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BalaJi
M.S. Chouhan
Advanced Problems in
Organic Chemistry
for JEE
11th EDITION
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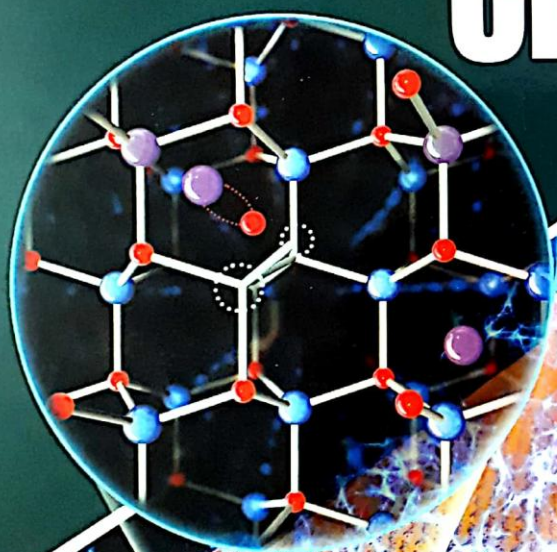

About the Author

Mahendra Singh Chouhan (MSC Sir) is a renowned name in the realm of Organic Chemistry. Through a Chemical Engineer from Mumbai University, his great passion for the subject led him to impart guidance to IIT-JEE aspirants on a regular basis. His in depth knowledge and vast experience has helped innumerable students to achieve their dream of excelling at IIT, JEE and other such tough challenges.

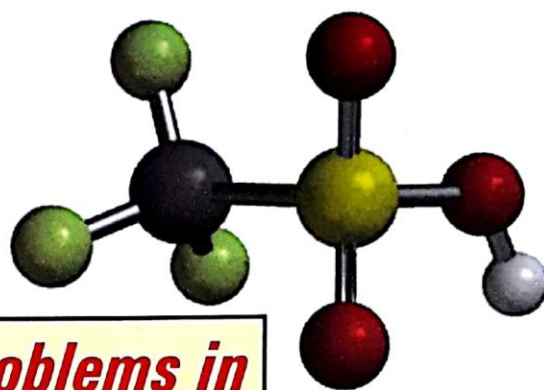
He has launched a website to extend the benefits of his expertise beyond the geographical barriers to all those who dare to dream and seek - **www.iitjeeorganic.com**.

The website provides expert guidance in all the areas of the subject in a most skillful manner. There are quizzes, challenging questions, notes, e-books and videos etc. This website is a complete guide in itself for organic chemistry and has been designed for IIT-JEE aspirants, keeping in mind the various syllabi and CBSE.

Highly recommended for the high flyers.

Advanced Problems in

ORGANIC CHEMISTRY

for

by:

M.S. Chouhan

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A few words to the JEE Aspirants

Dear JEE aspirants,

I hope that this collection of problems will surely help you during your preparation for JEE. In this book, each chapter consists of two levels :

Level 1 - includes the problems having only one option correct. These problems are based on different facts and their twists.

Level 2 - includes unique approach which may be used to solve the problems altogether different from the prevailing trend followed by JEE. These approaches will undoubtedly help you in the quick revision of the key facts and their applications.

I wish all of you a grand success in the ensuing Joint Entrance Examination. Your valuable suggestions and constructive criticism for the betterment of the book are welcome.

M.S. Chouhan

Preface

It is a matter of great pleasure for me to present the eleventh edition of **"Advanced Problems in Organic Chemistry for JEE"** before JEE aspirants. During my teaching experience, I felt that the facts may be made more and more clear to the students through problematic approach. Although an ocean of material in Organic Chemistry is available with the students, yet the approach to design the problems has been changed in recent years and if one tries to swim in this ocean, it will be a very difficult task. To make the students more familiar with trends and tricks how to solve problems, the present problem book has been presented. In the current scenario of stiff competition especially for JEE, one must be clear that almost all the sincere applicants are well equipped with the facts of subject, yet the winner is one who knows how to use these equipments with accuracy and efficiency. As an experienced teacher, I would like to suggest students three golden rules to score high in Organic Chemistry:

1. Don't get behind
2. Work out a number of problems of different types
3. Revise through short notes / learning chart.

I hope that the present book will cater to the needs of JEE aspirants & as a matter of fact, they will enjoy the present venture and I would feel rewarded if this book is found helpful to the students and teachers in real terms. All attempts have been made to make the book error free however a few misprints may inadvertently creep.

I acknowledge the blessing and support of my mother Smt. Raj Kanwar, father Shri B.S. Chouhan, brother Dr. V.S. Chouhan, my wife and daughter. They inspired me all the time during the preparation of this book.

The support and valuable suggestions from my colleagues especially Mr. N. Avasthi , Mr. V. K. jaiswal, Mr. Nitin Jain, Mr. N.K. Sethia, Mr. Vikash Gupta, Mr. Pankaj Joshi, Dr. S. Kothari, Mr. Vineet Khatri, Mr. Ashish Mishra, Mr. Manish Arora, Mr. Govind Khandelwal, Mr. Rahul Pareek, Mr. Rahul Malav, Mr. Divyesh Tiwari, Mr. Omkar Kelapure, Mr. Kishore Kilani, Mr. Mayank Pareek, Mr. Gurpreet Singh, Mr. Yogesh Jain, Madam Anjana Kamal , Mr. Aneet Choudhary, Mr. Shaliwahan Singh Rathore, Mr. Akshay Chaudhary, Mr. Hanuman Sahay, Mrs. Neha Joshi, Mrs. Neetu Jha, Mr. Kamlesh Gupta and Mr. Kumud Ranjan are highly acknowledged. I also pay my sincere thanks to all the esteemed members of **M/s Shri Balaji Publications** in bringing out this book in such a nice form.

In the last, constructive criticism and valuable suggestions from the readers are most welcome to make the book more useful.

M.S. CHOUHAN

Contents

LEARNING CHART (AROMATIC COMPOUND)
BENZENE
Aniline
Tribromo Aniline
Benzamide
Ammonium Benzoate
Benzoic Acid
Toluene or Methyl Benzene
Benzyl Chloride
Sod. Benzoate
Benzene Hexachloride or Gammaxine
Trinitro Toluene (Explosive) (TNT)
Benzene
Cyclo Hexane
Phenol
Picric acid
(2) HNO3/Δ (Better method for preparation of Picric acid)
maleic anhydride
Benzaldehyde
α,β Unsaturated acid or Cinnamic acid
Benzoic acid
(Esterification) reaction
Nitro Benzene
m-Dinitro Benzene
Selective red.
Sulphanilamide (used in sulpha drugs)
Sulphanilic acid or, Aniline Sulphonic acid
Benzene Sulphonic acid
Cumene
(Industrial Preparation of Phenol)
Benzene Diazoniumchloride
Chloro Benzene
Cyno Benzene
Sod.Phenolate
Salicylic acid
Acetophenone
Benzoyl Chloride
Tribromo-phenol (white ppt.)
Toluene (Clemmenson reduction)
Salicylaldehyde

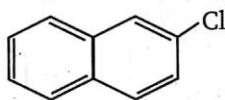
LEARNING CHART (ALIPHATIC)
Methane
Ethane
Ethyl bromide
Ethyl alcohol
Acetaldehyde
Acetic acid
Sodium acetate
Propanamine
propane nitrile
Propanoic acid
Propanoyl chloride
Propanamide
Ethyl amine
Ethylisonitrile
Acetylene
Ethylene
Glycol.
Glyoxal
Oxalic acid
Ethylene bromide
Ethylene Cyanide
Vinyl bromide
Succinic acid
Succinic anhydride
Dibromo Succinic acid
Ethanal
Ethyl alcohol
Acetone
(Clemmensen reduction)
(Wolf-Kishner reduction)
(Aldol-condensation)
Cyclic Acetal
Cyanohydrin
Baeyer villiger oxidation
Darzen - Process
Tollen's reagent
Reacts with Fehling solution
Williamson ether synthesis

LEARNING CHART OF PHENOL (A TO Z)
Prepration of Phenol
Dow process
+ NaOH
623 K
300 atm
ONa
HCl
SO3H
Benzene Sulphonic acid
(i) NaOH,350°C
(ii) H+
NH2
NaNO2
+ HCl
N2Cl
H3O+
Δ
Industrial prepration of phenol
CH3
C – O – O – H
CH3
(CUMENE HYDROPEROXIDE)
H3O+
50 – 90°C
Test of phenolic OH group
(1)
OH
conc. H2SO4
Δ
–H2O
NaOH
Pink colour
Phenophthalein Indicator
(2) 6C6H5OH + FeCl3 → [Fe(C6H5O6)]–3 + 3HCl + 3H+
neutral sol.
violet complex
(3) Liebermann nitroso Test
NaNO2
H2SO4,0°C
O=N–
–OH
dilution
Red colour
p-Nitrosophenol
deep green or blue colour
COOH
OCOCH3
(Aspirin)
Acetylation
CH3COCl
or
(CH3CO)2O
OH
COOH
(1) NaOH
(2) CO2, H+
SO3H
conc.
H2SO4
PHENOL
OR
CARBOLIC ACID
Zn dust
+ ZnO
(1) O3
(2) Zn + H2O
CHO
CHO
Na2Cr2O7,H+
(Benzoquinone)
Oxidation reaction
Reaction of Phenol
Dil HNO3
NO2
Conc. HNO3
2,4,6-trinitrophenol (PICRIC ACID)
Br2 in CS2
Br
Br2 water
CHCl3 + aq . NaOH
H+
CHO
Reimer tiemann formylation
Na/NaOH
ONa
NaOH
R — X(SN2)
X = Cl, Br, I, –SO3R
OR
(R – C)2O Or R – C – Cl
O – C – R
PhN2Cl
mild basic
HO–
–N = N –Ph
(Coupling reaction)
CCl4 + NaOH
COOH
(Reimer tiemann carboxylation)
H2,Ni
160°C
(Catalytic reduction)

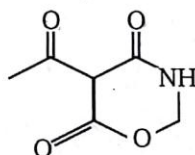
1 GENERAL ORGANIC CHEMISTRY

LEVEL- 1

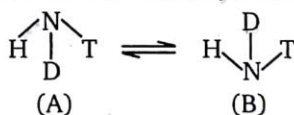
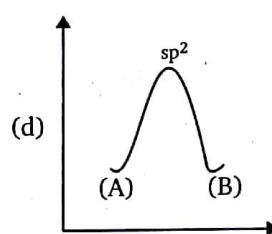
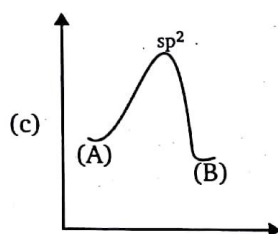
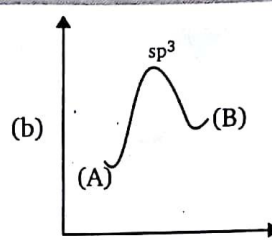
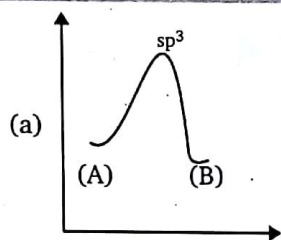
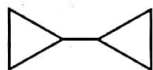
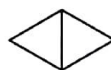
1. How many 2° Hydrogen atoms are present in the given following compound ?

Cl

(a) 2 (b) 5 (c) 7 (d) 8

2. Identify which functional group is **Not** present in the given following compound ?

O O NH O O

(a) Ketone (b) Ester (c) Amide (d) Ether

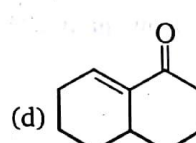
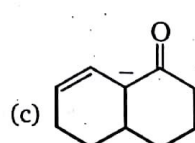
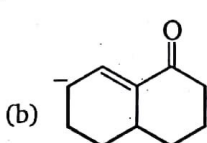
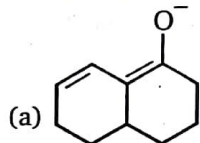
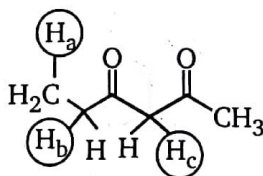
3. Correct energy profile for amine inversion and hybridization of nitrogen in transition state is:

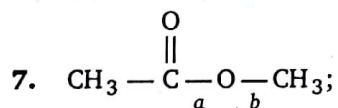
(A) ⇌ (B)

4. (i) (ii) (iii)

Correct order of the heats of combustion of above compounds is:

(a) (i) > (ii) > (iii) (b) (i) > (iii) > (ii) (c) (ii) > (i) > (iii) (d) (ii) > (iii) > (i)

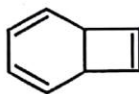
5. Which of the following is not a resonance structure of the others ?

(a) (b) (c) (d)

6. Rank the hydrogen atoms (H_a, H_b, H_c) present in the following molecule in decreasing order of their acidic strength.

(a) $a > b > c$ (b) $b > a > c$ (c) $b > c > a$ (d) $c > b > a$

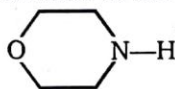
7. $CH_3-\overset{\overset{\displaystyle O}{\|}}{C}\underset{a}{-}O\underset{b}{-}CH_3$;

The correct relation between the bond lengths a and b is:

(a) $a = b$ (b) $b > a$

(c) $b < a$ (d) Impossible to predict

8. The number of $sp^2 - sp^2$ sigma bonds in the compound given below is :

(a) 1 (b) 3 (c) 4 (d) 5

9. The total number of lone pair of electrons in the given molecule is :

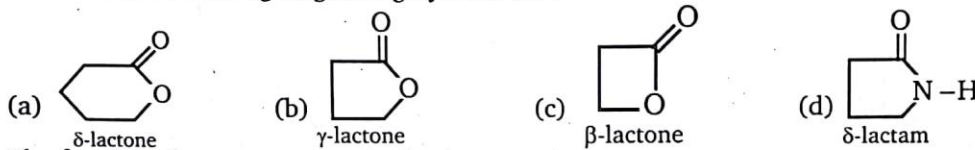
O N—H

(a) 2 (b) 3 (c) 4 (d) 5

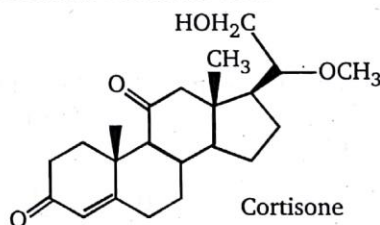
10. Which of the following rings is highly strained ?

(a)
δ-lactone

(b) γ-lactone

(c) β-lactone

(d) N–H
δ-lactam

11. The functional groups present in Cortisone are :

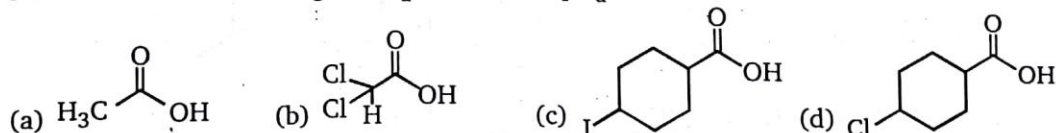
Cortisone

(a) ether, alkene, alcohol (b) alcohol, ketone, alkene, ether
(c) alcohol, ketone, amine (d) ether, amine, ketone

12. Select the acid with the highest K_a (*i.e.*, lowest pK_a).

(a)

(b) Cl, Cl, H, O, OH

(c) I, O, OH

(d) Cl, O, OH

13. Most stable carbocation among the following is :

(a)

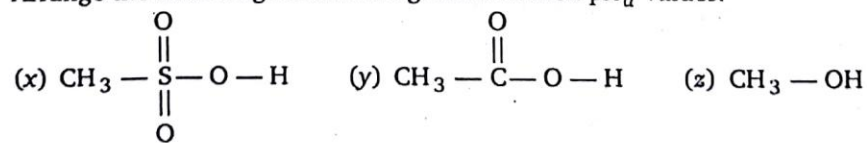
(b) ⊕

(c)

(d) $^{\oplus}CH_3$

14. Arrange the following in increasing order of their pK_a values.

(*x*)

(*y*) $CH_3 - \overset{O}{\overset{\|}{C}} - O - H$ (*z*) $CH_3 - OH$

(a) $y < x < z$ (b) $x < y < z$ (c) $y < z < x$ (d) $x < z < y$

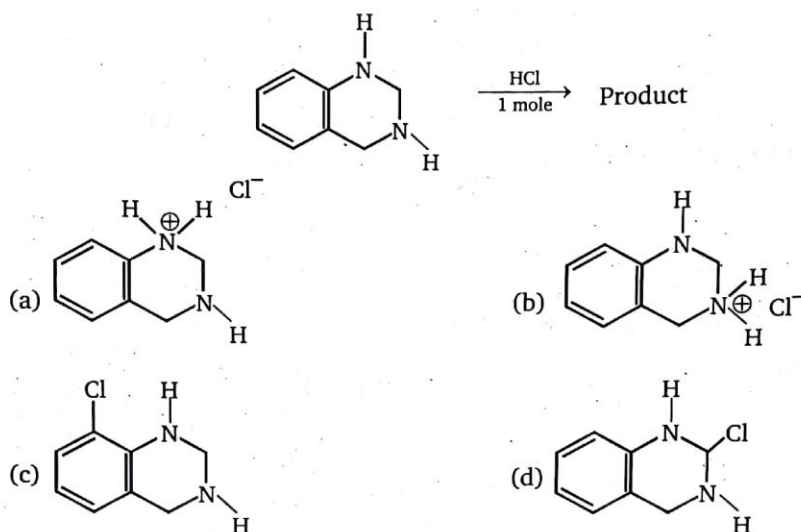
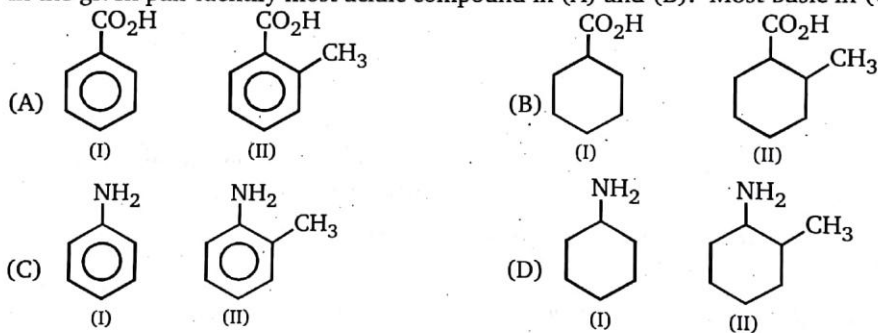
15. Which is the major product of the following reaction ?

$\xrightarrow[\text{1 mole}]{\text{HCl}}$ Product

(a)

(b)

(c)

(d)

16. In the given pair identify most acidic compound in (A) and (B). Most basic in (C) and (D).

(a) A - I, B - II, C - I, D - II
(b) A - II, B - I, C - I, D - II
(c) A - II, B - II, C - II, D - II
(d) A - I, B - II, C - I, D - I

17. Several factors (steric, electronic, orbital interactions etc.) can affect the inversion barrier of an amine. In the given pair which data is correctly placed ?

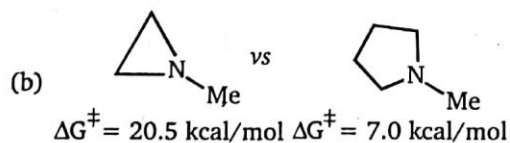
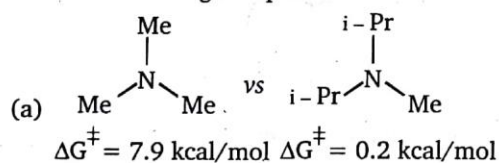
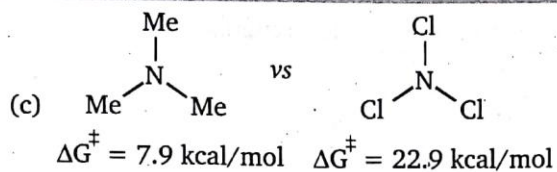
(a) Me_3N *vs* $(i\text{-}Pr)_2NMe$

$\Delta G^{\ddagger} = 7.9$ kcal/mol $\Delta G^{\ddagger} = 0.2$ kcal/mol

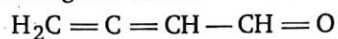
(b) N-Me aziridine *vs* N-Me pyrrolidine

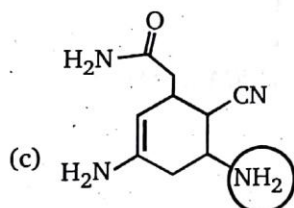
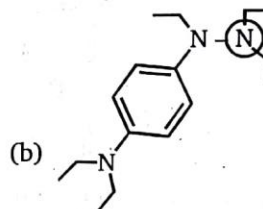
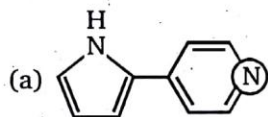
$\Delta G^{\ddagger} = 20.5$ kcal/mol $\Delta G^{\ddagger} = 7.0$ kcal/mol

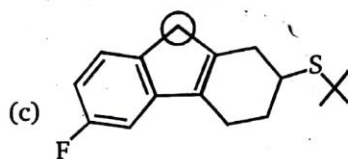
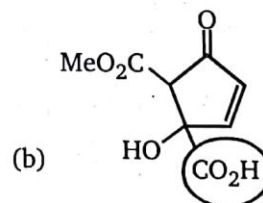
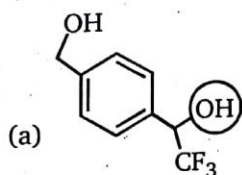
(c) $N(Me)_3$ *vs* NCl_3

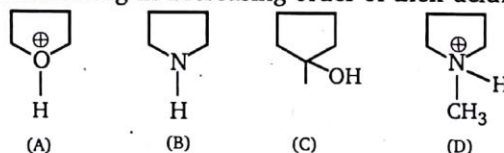
$\Delta G^{\ddagger} = 7.9$ kcal/mol $\quad \Delta G^{\ddagger} = 22.9$ kcal/mol

(d) All of these

18. Select the response that correctly identifies the number of carbon atoms of each type of hybridization in the compound given below

$$H_2C=C=CH-CH=O$$

	sp^3	sp^2	sp		sp^3	sp^2	sp
(a)	2	2	0	(b)	1	3	0
(c)	0	3	1	(d)	1	2	1

19. Circle represents most basic atoms in these molecule. Which of the following is correct representation ?

(d) All of these

20. Circle represent most acidic hydrogens in these molecules. Which of the following is correct representation ?

(d) All of these

21. Arrange the following in decreasing order of their acidic strengths.

(a) A > C > B > D (b) A > D > B > C (c) A > D > C > B (d) D > A > C > B

22.

Cyclopropane (I) Cyclobutane (II) Cyclopentane (III)

The correct order of heats of combustion of above compounds is :

(a) I > II > III (b) II > I > III
(c) III > II > I (d) III > I > II

23. (A) (B) (C)

Compare carbon-carbon bond rotation across A, B, and C

(a) A > B > C (b) A > C > B
(c) B > A > C (d) B > C > A

24. Which of the following acids would have a STRONGER CONJUGATE BASE ?

(A) H_2S *vs* H_2O
1 2

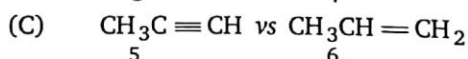
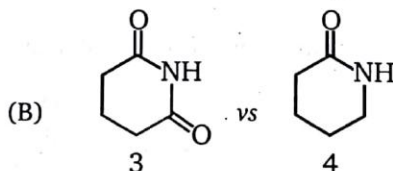
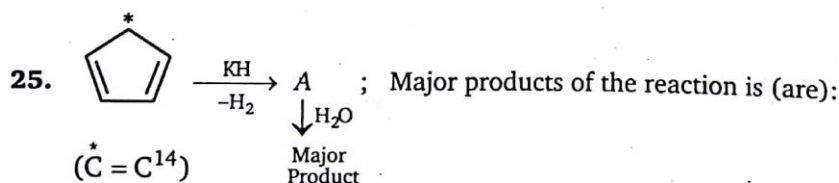
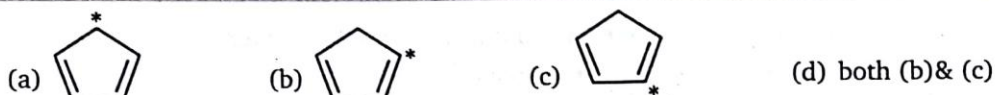
(B)

(C) $CH_3C\equiv CH$ *vs* $CH_3CH=CH_2$
5 6

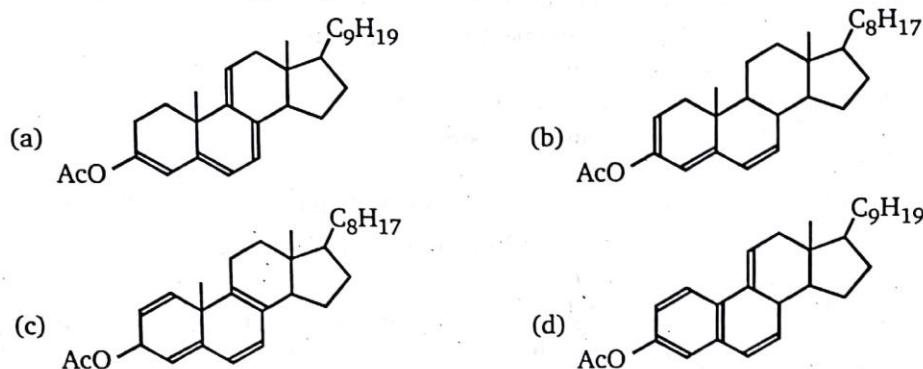
(a) 2, 4, 6 (b) 1, 3, 5 (c) 2, 3, 5 (d) 1, 3, 6

25. (cyclopentadiene, labelled *) $\xrightarrow[-H_2]{KH}$ *A* $\xrightarrow{H_2O}$ Major Product ; Major products of the reaction is (are):

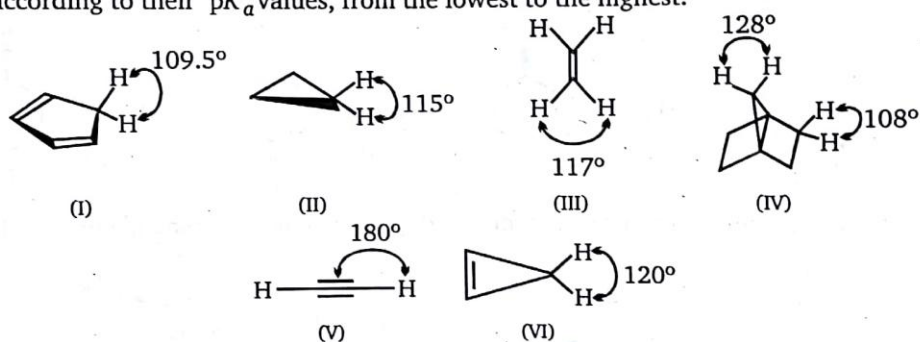
($\overset{*}{C} = C^{14}$)

(a) * (b) * (c) * (d) both (b)& (c)

26. Which of the following compound is most stable ?

(a) AcO, C_9H_{19} (b) AcO, C_8H_{17}

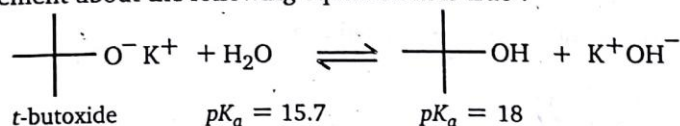
(c) AcO, C_8H_{17} (d) AcO, C_9H_{19}

27. Selected bond angles for six hydrocarbons are shown below. Arrange these hydrocarbons according to their pK_a values, from the lowest to the highest.

H H H H 117° (III)

128° H H H 108° H (IV)

(a) V < I < VI < II < III < IV (b) IV < I < II < III < V < VI
(c) II < IV < I < VI < V < III (d) I < V < IV < III < II < VI

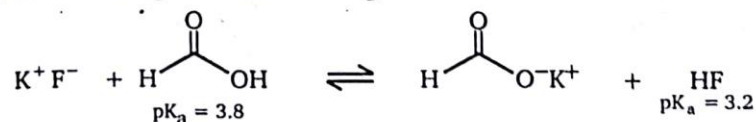
28. Which statement about the following equilibrium is true ?

$$\text{t-butoxide } O^-K^+ + H_2O \rightleftharpoons \text{t-butanol } OH + K^+OH^-$$

t-butoxide, $pK_a = 15.7$ (H_2O), $pK_a = 18$ (t-butanol)

(a) The equilibrium favours the products
(b) *t*-Butoxide is the dominant anionic species in the equilibrium
(c) Water is the weaker acid
(d) *t*-Butoxide is stabilized by resonance

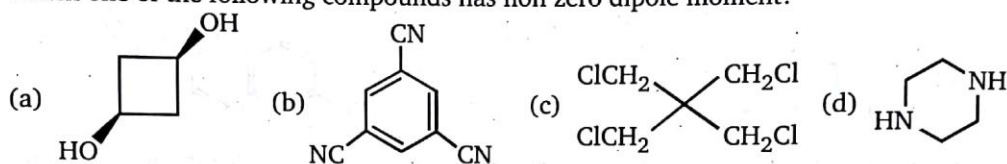
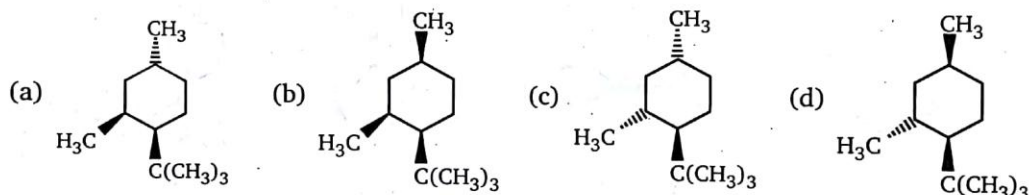
29. Consider the following reaction involving two acids shown below : formic acid and HF.

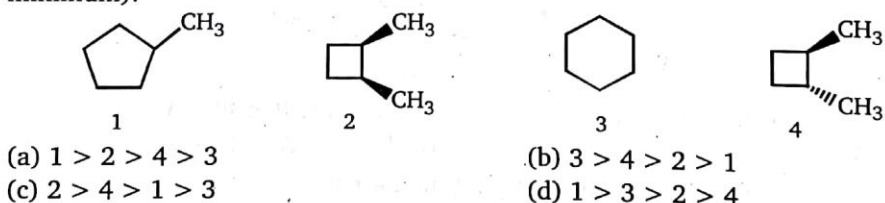
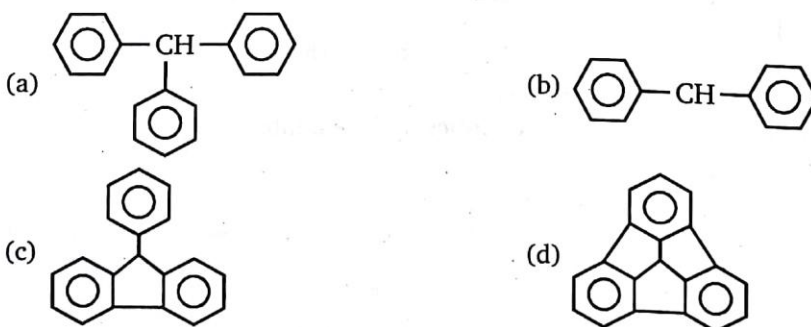
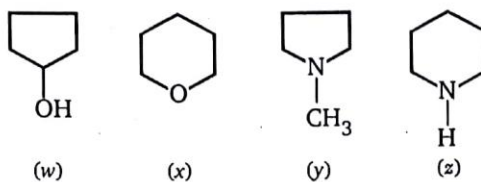
$$K^+F^- + HCOOH \rightleftharpoons HCOO^-K^+ + HF$$

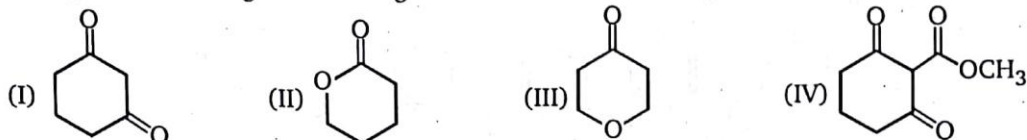
HCOOH: $pK_a = 3.8$; HF: $pK_a = 3.2$

Which of the following statements about this reaction are true ?

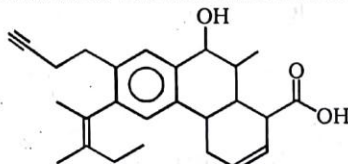
(A) Formic acid is the strongest Bronsted acid in the reaction
(B) HF is the strongest Bronsted acid in the reaction
(C) KF is the strongest Bronsted base in the reaction
(D) KO_2CH is the strongest Bronsted base in the reaction
(E) The equilibrium favours the reactants
(F) The equilibrium favours the products
(G) Formic acid has a weaker conjugate base
(H) HF has a weaker conjugate base

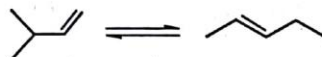
(a) A, D and F (b) B, D, and H (c) A, C, and H (d) B, D, E and H

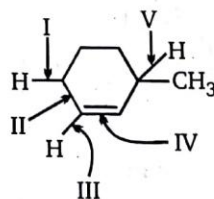
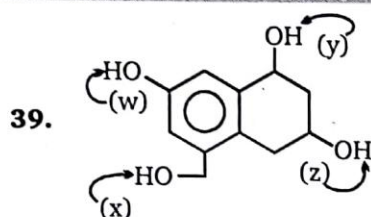
30. Which one of the following compounds has non zero dipole moment?

31. Which one of the following has the smallest heat of combustion ?

32. Rank the following substances in order of decreasing heat of combustion (maximum → minimum).

(a) 1 > 2 > 4 > 3
(b) 3 > 4 > 2 > 1
(c) 2 > 4 > 1 > 3
(d) 1 > 3 > 2 > 4

33. Which of the following has lowest pK_a value ?

34. Arrange the following (w, x, y, z) in decreasing order of their boiling points:

(a) $w > x > z > y$ (b) $w > x > y > z$
(c) $w > z > y > x$ (d) $w > z > x > y$

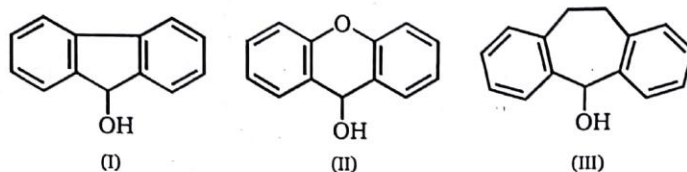
35. Arrange the following in increasing order of their acidic strength.

(a) III < I < IV < II (b) II < I < IV < III
(c) I < III < IV < II (d) II < III < I < IV

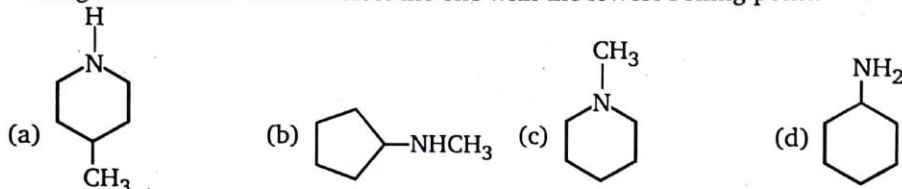
36. How many degrees of unsaturation are there the following compound ?

(a) 6 (b) 7 (c) 10 (d) 11

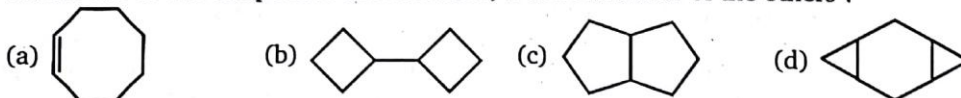
37. The heat of hydrogenation for 3-methylbutene and 2-pentene are –30 kcal/mol and –28 kcal/mol respectively. The heats of combustion of 2-methylbutane and pentane are – 784 kcal/mol and –782 kcal/mol respectively. All the values are given under standard conditions. Taking into account that combustion of both alkanes give the same products, what is ΔH (in kcal/mol) for the following reaction under same conditions ?

(a) 0 (b) – 4 (c) – 2 (d) 2

38. Which of the following σ-bonds participate in hyperconjugation ?

(a) I and II (b) I and V (c) II and V (d) III and IV

39. Decreasing order of acidic strength of different (–OH) groups is :

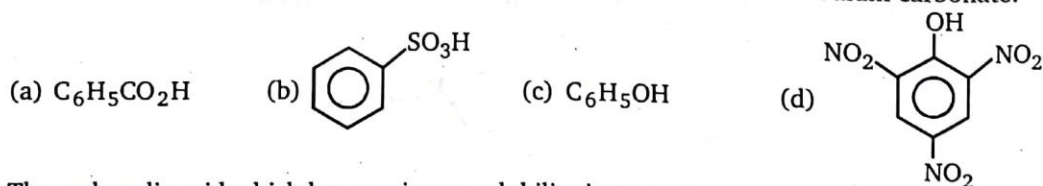
(a) $w > x > y > z$ (b) $w > z > x > y$ (c) $z > w > x > y$ (d) $z > x > w > y$

40. Arrange the following alcohols in decreasing order of the ease of ionization under acidic conditions.

(a) I > III > II (b) I > II > III (c) II > III > I (d) II > I > III

41. Among the isomeric amines select the one with the lowest boiling point.

42. Which one of the compounds shown below, is not an isomer of the others ?

(a) (b) (c) (d)

43. Arrange the anions (p) $\bar{C}H_3$, (q) $\bar{N}H_2$, (r) OH^-, (s) F^-, in decreasing order of their basic strength.

(a) $p > q > r > s$ (b) $q > p > r > s$ (c) $r > q > p > s$ (d) $r > p > q > s$

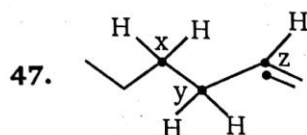
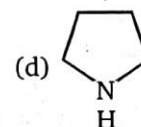
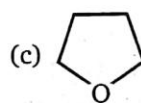
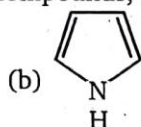
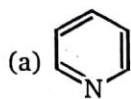
44. One among the following compounds will not give effervescence with sodium carbonate:

45. The carboxylic acid which has maximum solubility in water is:

(a) phthalic acid (b) succinic acid

(c) malonic acid (d) salicylic acid

46. Among the following compounds, the most basic compound is :

(a) (b) (c) (d)

47.

Arrange the (C – H) bonds x, y and z in decreasing order of their bond dissociation energies in homolysis.

(a) $y > x > z$ (b) $z > x > y$ (c) $z > y > x$ (d) $y > z > x$

48. 23 g of sodium will react with methyl alcohol to give :

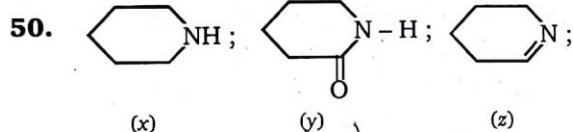
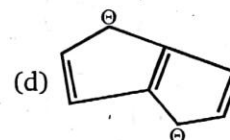
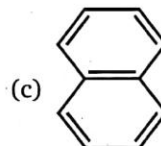
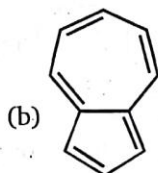
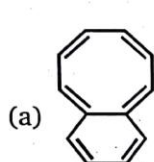
(a) one mole of oxygen (b) $22.4\ dm^3$ of hydrogen gas at NTP

(c) 1 mole of H_2 (d) 11.2 L of hydrogen gas at NTP

49. Which of the following is most polar?

(a) (b) (c) (d)

50. NH ; N – H ; N ;

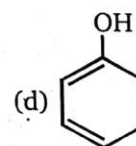
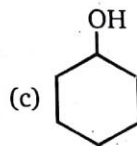
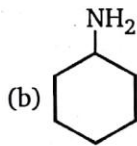
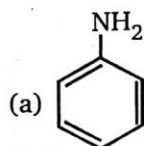
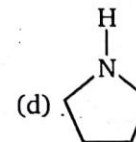
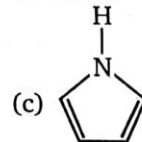
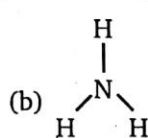
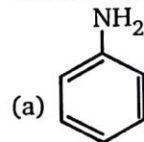
(x) (y) (z)

The correct order of decreasing basic strengths of x, y and z is :

(a) $x > y > z$ (b) $x > z > y$ (c) $y > x > z$ (d) $y > z > x$

51. Which of the following is the strongest Bronsted acid ?

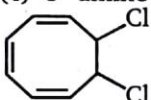
(a) (b) (c) (d)

52. Which of the following is the strongest Bronsted base ?

(a) (b) NH_3 (c) (d)

53. Which of the following is polar aprotic solvent ?

(a) DMSO (b) Crown ether (c) DMG (d) All of these

54. Some pairs of acids are given below. Select the pair in which second acid is stronger than first

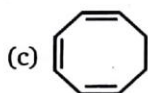
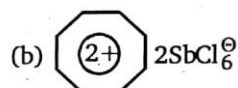
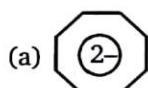
(a) CH_3CO_2H and CH_2FCO_2H
(b) CH_2FCO_2H and CH_2ClCO_2H
(c) CH_2ClCO_2H and CH_2BrCO_2H
(d) $CH_3CH_2CHFCO_2H$ and $CH_3CHFCH_2CO_2H$

55. $H-C\equiv C\overset{a}{-}C\equiv C\overset{b}{-}CH_3$;

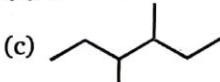
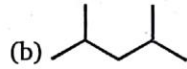
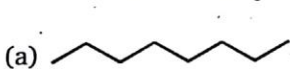
Compare the bond lengths a and b:

(a) $a = b$ (b) $a > b$ (c) $b > a$ (d) $a >>> b$

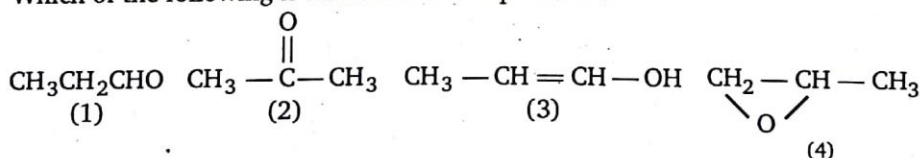
56. Which (isomeric) amine has lowest boiling point ?

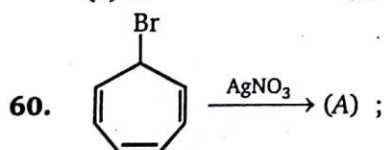
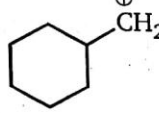
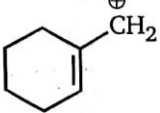
(a) 1° amine (b) 2° amine
(c) 3° amine (d) cannot predict

57. [5,6-dichlorocycloocta-1,3,7-triene] $\xrightarrow{2SbCl_5}$ P ; P will be :

(a) [cyclooctatetraene ring with 2−] (b) [cyclooctatetraene ring with 2+] $2SbCl_6^{\ominus}$
(c) [cyclooctatetraene] (d) mixture of (a) and (b)

58. Which of the following substances is not an isomer of 3-ethyl 2-methyl pentane ?

(a) [zigzag chain structure] (b) [branched structure]
(c) [branched structure] (d) All are isomers

59. Which of the following is an isomer of compound 1 ?

CH_3CH_2CHO (1) $CH_3-\overset{O}{\overset{\|}{C}}-CH_3$ (2) $CH_3-CH=CH-OH$ (3) $CH_2-CH-CH_3$ (epoxide, O bridging) (4)

(a) 2 (b) 4 (c) 2 and 3 (d) all are isomers

60. [5-bromocyclohepta-1,3-diene ring with Br] $\xrightarrow{AgNO_3}$ (A) ;

Which statement is incorrect in respect of the above reaction ?

(a) Product is aromatic (b) Product has high dipole moment
(c) Product has less resonance energy (d) Product is soluble in polar solvent

61. Some pairs of ions are given below. In which pair, first ion is more stable than second?

(a) $CH_3-\overset{\oplus}{C}H-CH_3$ and $CH_3-\overset{\oplus}{C}H-OCH_3$

(b) $CH_3-CH_2-\overset{\oplus}{C}H-CH_3$ and $CH_2=CH-CH_2-\overset{\oplus}{C}H_2$

(c)

(d)
$CH_3-CH-CH_3$ and CH_3-N-CH_3
$\quad\;\; |$
$CH_2-C^{\oplus}-CH_3$ $\quad CH_3-C^{\oplus}-CH_3$

62. Among the given pairs in which pair, first compound has higher boiling point than second ?

(a) $CH_3-CH_2OCH_3$ and $CH_3-\underset{\underset{OH}{|}}{CH}-CH_3$

(b) $CH_3-CH_2-CH_2-CH_3$ and $CH_3-CH_2-CH_3$

(c) $CH_3-CH_2-CH_2-CH_2-CH_3$ and $CH_3-\underset{}{\overset{\overset{CH_2-CH_3}{|}}{CH}}-CH_2-OH$

(d) $CH_3-CH_2-CH_2-CH_3$ and $CH_3-CH_2-CH_2-Cl$

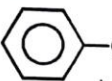
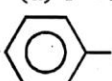
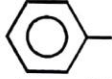
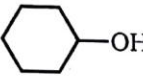
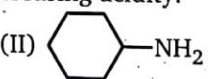
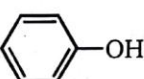
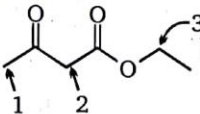
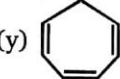
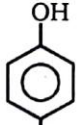
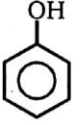
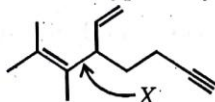
63. Which of the following alcohols is the least soluble in water ?

(a) Ethanol (b) 1-Propanol
(c) 1-Butanol (d) 1-Pentanol

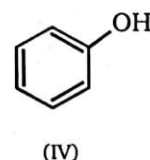
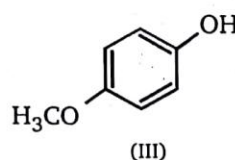
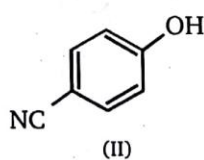
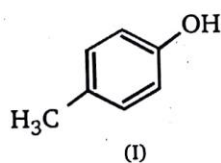
64. Which of the following alcohols is expected to have a lowest pK_a value ?

(a) Ethanol (b) 1-propanol
(c) 2, 2, 2-trifluorethanol (d) 2-chloroethanol

65. Which of the following alkenes is the most stable ?

(a) (b) (c) (d)

66. Bond X is made by the overlap of which type of hybridized orbitals ?

(a) sp and sp^3 (b) sp and sp^2
(c) sp^2 and sp^3 (d) none of these

67. Increasing order of acidic strength of given compounds is :

OH / H_3C (I) OH / NC (II) OH / H_3CO (III) OH (IV)

(a) III < I < IV < II (b) II < I < IV < III
(c) I < III < IV < II (d) I < III < II < IV

68. C_6H_5–COOH + $NaH\overset{*}{C}O_3 \longrightarrow CO_2$ + C_6H_5–COONa, $\overset{*}{C}$ is with the product :

(a) CO_2 (b) C_6H_5–COONa (c) both (d) none of these

69. Rank in the order of increasing acidity.

(I) (cyclohexyl)–OH (II) (cyclohexyl)–NH_2 (III) (phenyl)–OH

(a) III < I < II (b) I < III < II
(c) III < II < I (d) II < I < III

70. Which compound has the highest value of pK_a?

(a) $Cl-CH_2-CH_2-COOH$ (b) CH_3-CH_2-COOH

(c) $CH_3-CH(Cl)-COOH$ (d) $CH_3-C(Cl)_2-COOH$

71. Consider the hydrogen atoms attached to three different carbon atoms (labeled 1, 2 & 3). Rank the attached hydrogen atoms in order from most acidic to least acidic.

CH_3(1)–CO–CH_2(2)–CO–O–CH_2(3)–CH_3

(a) 2 > 1 > 3 (b) 1 > 2 > 3 (c) 2 > 3 > 1 (d) 3 > 2 > 1

72. Decreasing order of acidic strengths of following compounds is :

(x) (y) (z)

(a) $x > y > z$ (b) $y > x > z$ (c) $z > y > x$ (d) $z > x > y$

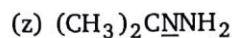
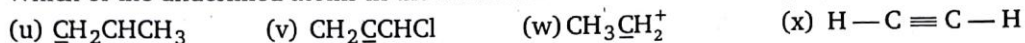
73. Among the given pairs, in which pair second compound is more acidic than first ?

(a) $BrCH_2NO_2$ and CH_3CH_3 (b) $CH_3-\overset{O}{\overset{||}{C}}CH_2CN$ and $CH_3-\overset{O}{\overset{||}{C}}-CH_3$

(c) (d)

74. Which of the underlined atoms in the molecules shown below have *sp*-hybridization ?

(u) $\underline{C}H_2CHCH_3$ (v) $CH_2\underline{C}CHCl$ (w) $CH_3\underline{C}H_2^+$ (x) $H-C\equiv C-H$

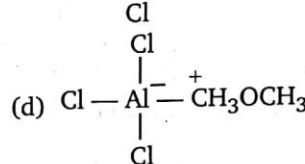
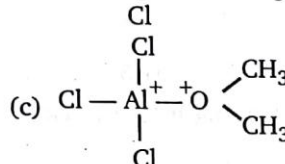
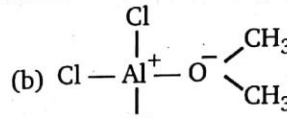
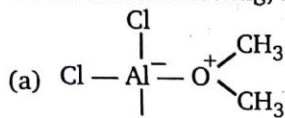
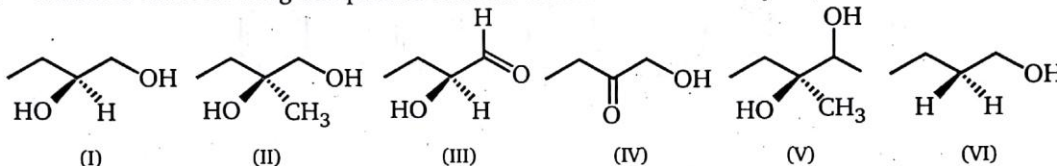
(y) $CH_3\underline{C}N$ (z) $(CH_3)_2\underline{CN}NH_2$

(a) x and z (b) x, y, and z (c) u, w and x (d) v, x and y

75. Which of the following, is the product of the reaction between $AlCl_3$ and CH_3OCH_3 ?

(a)

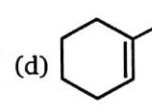
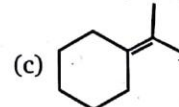
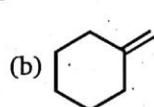
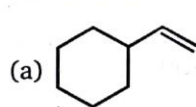
(b) $Cl-\overset{+}{Al}(Cl)_2-\overset{-}{O}(CH_3)_2$

(c) $Cl-\overset{+}{Al}(Cl)_2-\overset{+}{O}(CH_3)_2$

(d) $Cl-\overset{-}{Al}(Cl)_2-\overset{+}{C}H_3OCH_3$

76. Which of the following compounds contain at least one secondary alcohol ?

(I) (II) (III) (IV) (V) (VI)

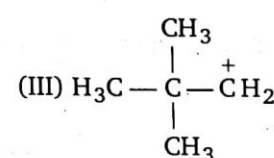
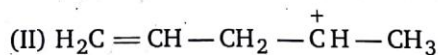
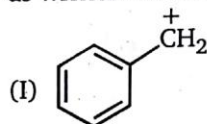
(a) I, II, IV, VI (b) I, III (c) I, II, III, V (d) I, III, V

77. Which of the following has the most negative heat of hydrogenation ?

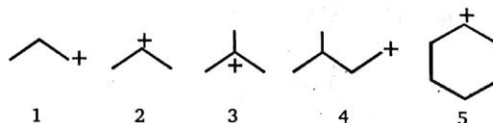
(a) (b) (c) (d)

78. Which of the following options is the correct order of relative stabilities of cations I, II and III as written below (most stable first) ?

(I)

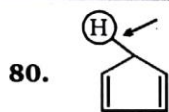
(II) $H_2C=CH-CH_2-\overset{+}{C}H-CH_3$

(III)

(a) I > II > III (b) II > III > I (c) III > I > II (d) I > III > II

79. What is the decreasing order of stability (most stable → least stable) of the following carbocations ?

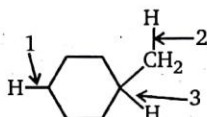
1 2 3 4 5

(a) 3 > 2 > 1 > 4 > 5 (b) 3 > 2 > 5 > 4 > 1

(c) 1 ≈ 4 > 2 ≈ 5 > 3 (d) 3 > 1 ≈ 4 > 2 ≈ 5

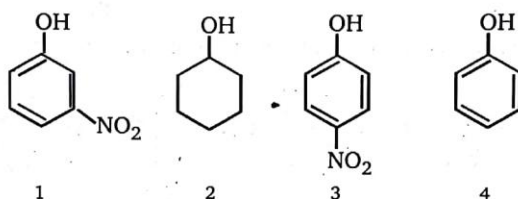
80.

the hydrogen indicated by arrow will be easily removed as :

(a) H^+ (b) $H^{\ominus}$ (c) $H^{\bullet}$ (d) H^{-2}

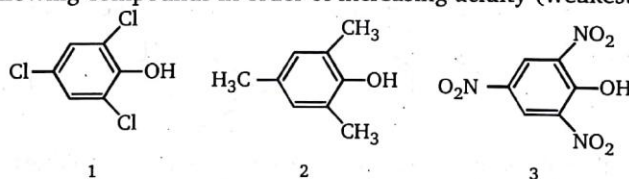
81. Rank the bond dissociation energies of the bonds indicated with the arrows. (from smallest to largest).

H, 1, 2, CH_2, H, 3

(a) 1 < 2 < 3 (b) 3 < 2 < 1 (c) 2 < 3 < 1 (d) 3 < 1 < 2

82. Rank the following compounds in order of decreasing acid strength (most acidic → least acidic) .

OH, NO_2 (1); OH (2); OH, NO_2 (3); OH (4)

(a) 2 > 4 > 1 > 3 (b) 1 > 3 > 4 > 2 (c) 3 > 1 > 2 > 4 (d) 3 > 1 > 4 > 2

83. Rank the following compounds in order of increasing acidity (weakest acid first).

Cl, Cl, OH, Cl (1); CH_3, H_3C, OH, CH_3 (2); NO_2, O_2N, OH, NO_2 (3)

(a) 2 < 3 < 1 (b) 3 < 1 < 2 (c) 1 < 2 < 3 (d) 2 < 1 < 3

84. Which of the following phenols has the largest pK_a value (*i.e.*, is least acidic) ?

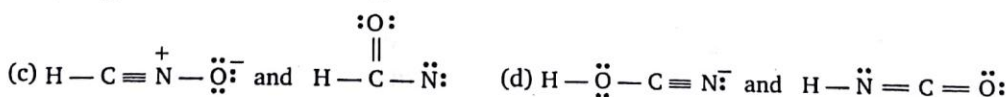
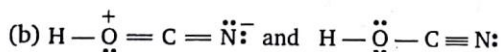
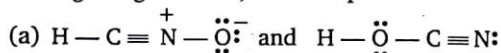
(a) Cl—C_6H_4—OH (b) O_2N—C_6H_4—OH

(c) H_3C—C_6H_4—OH (d) N≡C—C_6H_4—OH

85. Among the given sets, which represents the resonating structures ?

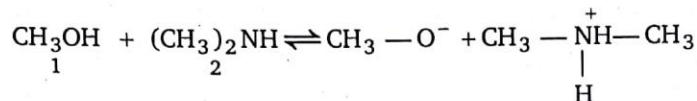
(a) $H-C\equiv \overset{+}{N}-\ddot{\underset{..}{O}}:^-$ and $H-\ddot{\underset{..}{O}}-C\equiv N:$

(b) $H-\overset{+}{\underset{..}{O}}=C=\ddot{N}:^-$ and $H-\ddot{\underset{..}{O}}-C\equiv N:$

(c) $H-C\equiv \overset{+}{N}-\ddot{\underset{..}{O}}:^-$ and $H-\underset{}{\overset{:O:}{\overset{\|}{C}}}-\ddot{N}:$ (d) $H-\ddot{\underset{..}{O}}-C\equiv N:^-$ and $H-\ddot{N}=C=\ddot{O}:$

86. Identify each species in the following equilibrium according to the code :

SA = stronger acid ; SB = stronger base ; WA = weaker acid ; WB = weaker base.

The pK_a of $(CH_3)_2NH$ is 36 ; the pK_a of CH_3OH is 15.2.

$$\underset{1}{CH_3OH} + \underset{2}{(CH_3)_2NH} \rightleftharpoons CH_3-O^- + CH_3-\overset{+}{N}H(H)-CH_3$$

	1	2		1	2		1	2		1	2
(a)	WA	WB	(b)	WB	WA	(c)	SA	SB	(d)	SB	SA
(e)	WA	WA									

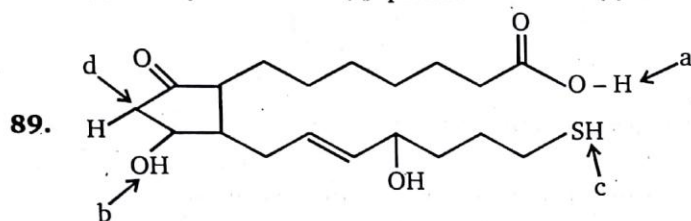
87. The hydrogen bonding is strongest in which one of the following set ?

(a) F — H - - - F (b) O — H - - - S (c) S — H - - - F (d) F — H - - - O

88. Intermolecular hydrogen bonding is strongest in :

(a) methylamine (b) phenol (c) formaldehyde (d) methanol

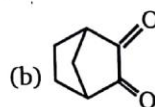
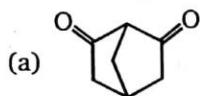
89.

d, O, H, OH, b, O, O – H ← a, SH, ↑ c, OH

Identify most acidic hydrogen in given compound.

(a) *a* (b) *b* (c) *c* (d) *d*

90. Which of the following compounds would you expect to be strongest carbon acid ?

(a)

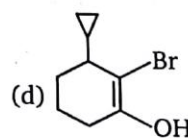
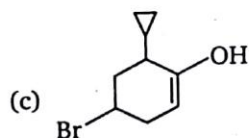
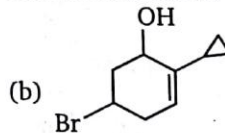
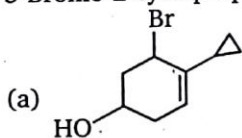
(b)

(c) $CH_2(CO_2Et)_2$ (d) $CH_3COCH_2COOC_2H_5$

91. 5-Bromo-2-cyclopropyl cyclohex-2-enol have correct structure is:

(a)

(b)

(c) OH, Br

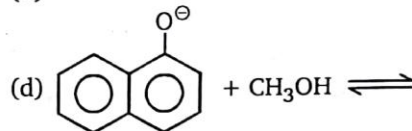
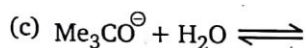
(d) Br, OH

92. Rearrange the following in the increasing order of acidic strength.

(i) benzoic acid (ii) *p*-methoxybenzoic acid (iii) *o*-methyoxybenzoic acid

(a) i < ii < iii (b) iii < i < ii (c) ii < i < iii (d) iii < ii < i

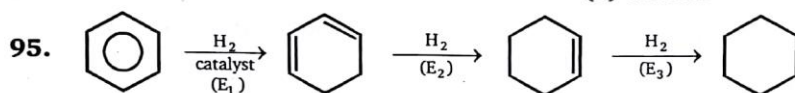
93. In the following acid-base reaction, in which can backward reaction if favoured?

(a) $EtO^{\ominus}$ + —OH $\rightleftharpoons$ (b) KH + EtOH $\rightleftharpoons$

(c) $Me_3CO^{\ominus} + H_2O \rightleftharpoons$ (d) $O^{\ominus}$ (naphthoxide) $+ CH_3OH \rightleftharpoons$

94. Which compound posses highest dipole moment ?

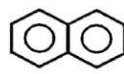
(a) naphthalene (b) phenanthrene

(c) anthracene (d) azulene

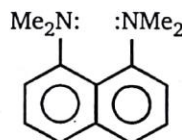
95. Benzene $\xrightarrow[\text{catalyst } (E_1)]{H_2}$ Cyclohexadiene $\xrightarrow[(E_2)]{H_2}$ Cyclohexene $\xrightarrow[(E_3)]{H_2}$ Cyclohexane

(E = activation energy)

Relation between activation energies of above reactions is :

(a) $E_2 > E_1 > E_3$ (b) $E_3 > E_1 > E_2$ (c) $E_3 > E_2 > E_1$ (d) $E_1 > E_2 > E_3$

96. Rank the following solvents in decreasing order of ability to dissolve given compound.

(a) $Et_2O > H_2O > EtOH$ (b) $H_2O > EtOH > Et_2O$

(c) $H_2O > Et_2O > EtOH$ (d) $Et_2O > EtOH > H_2O$

97.

1, 8-Bis (dimethylamino) naphthalene is after referred so as (Proton sponge)

Its basic strength is 10^{10} more than 1-dimethyl amino naphthalene.

Reason for high basic strength is :

(a) resonance (b) steric inhibitation of resonance

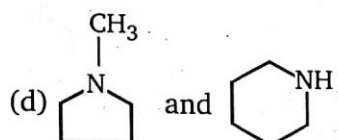
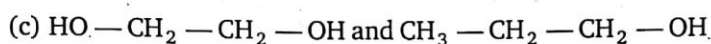
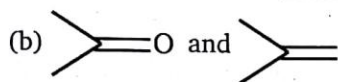
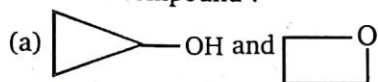
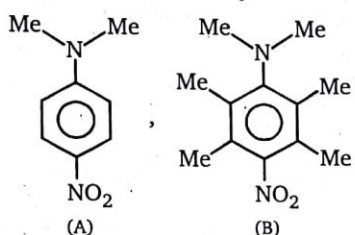
(c) ortho effect (d) hyperconjugation

98. In the given pair of compounds, in which pair second compound has higher boiling point than first compound ?

(a)

(b) =O and =

(c) HO — CH_2 — CH_2 — OH and CH_3 — CH_2 — CH_2 — OH

(d)

99. Me, Me N; Me, Me N, Me, Me, Me, Me; NO_2 (A), NO_2 (B) ; Dipole moments of given compound will be :

(a) (A) = 6.87D, (B) = 4.11D
(b) (A) = 4.11 D , (B) = 6.87 D
(c) (A) = 4.11 D , (B) = 4.11 D
(d) (A) = 6.87 D, (B) = 6.87 D

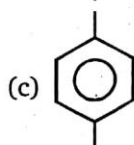
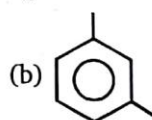
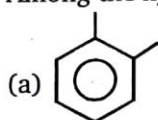
100. Order of decreasing basic strengths of halides is :

(a) $F^- > Cl^- > I^- > Br^-$
(b) $F^- > Cl^- > Br^- > I^-$
(c) $I^- > Br^- > Cl^- > F^-$
(d) $I^- > Cl^- > Br^- > F^-$

101. Among the xylenes, which is thermodynamically most stable ?

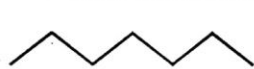
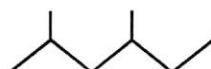
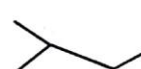
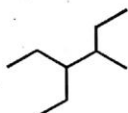
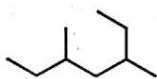
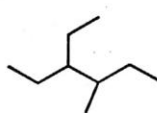
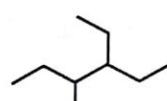
(a)

(b)

(c)

(d) All are equally stable

102. Heat of combustion of two isomer x and y are 17 kJ/mol and 12 kJ/mol respectively. From this information it may be concluded that :

(a) isomer x is 5 kJ /mol more stable
(b) isomer y is 5 kJ/mol less stable
(c) isomer y has 5 kJ/mol more potential energy
(d) isomer x is 5 kJ/mol less stable

103. Rank the following substances in decreasing order of heat of combustion (most exothermic $\longrightarrow$ least exothermic)

(a) B > A > C (b) A > B > C (c) C > A > B (d) C > B > A

104. (1) (2) (3) (4)

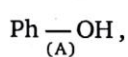
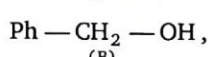
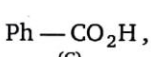
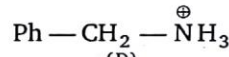
Choose the statement that best describes given compounds.

(a) 1, 3, 4 represent same compound (b) 1 and 3 are isomer of 2 and 4

(c) 1, 4 are isomer of 2 and 3

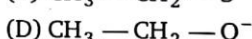
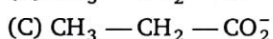
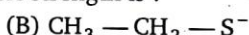
(d) All the structure represent the same compound

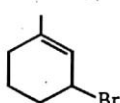
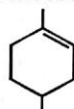
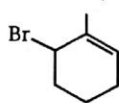
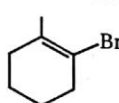
105. Decreasing order of acid strengths is :

$\underset{(A)}{Ph-OH}$, $\underset{(B)}{Ph-CH_2-OH}$, $\underset{(C)}{Ph-CO_2H}$, $\underset{(D)}{Ph-CH_2-\overset{\oplus}{N}H_3}$

(a) B > A > C > D (b) C > A > B > D (c) C > A > D > B (d) C > B > A > D

106. Rank the following in decreasing order of basic strength is :

(A) $CH_3-CH_2-C\equiv C^-$ (B) $CH_3-CH_2-S^-$

(C) $CH_3-CH_2-CO_2^-$ (D) $CH_3-CH_2-O^-$

(a) B > A > D > C (b) D > A > B > C (c) A > D > B > C (d) A > D > C > B

107. Among the given compound choose the two that yield same carbocation on ionization.

(a) A, C (b) B, D (c) A, B (d) B, C

108. Oxalic acid pK_1

Malonic acid pK_2

Heptanedioic acid pK_3

where pK_1, pK_2, pK_3 are first ionization constants. Incorrect order is :

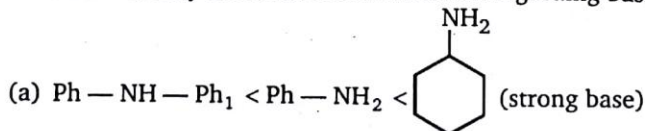
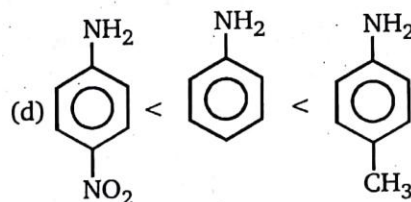
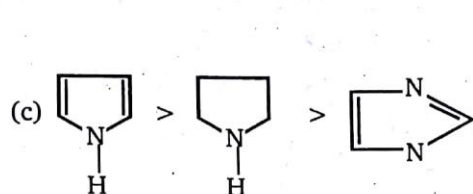
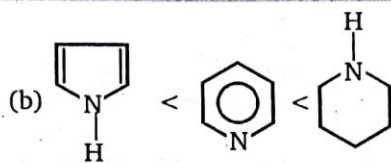
(a) $pK_1 > pK_2 > pK_3$ (b) $pK_1 < pK_2 < pK_3$ (c) $pK_3 > pK_2 > pK_1$ (d) $pK_3 > pK_1 > pK_2$

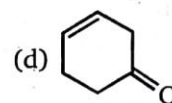
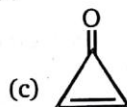
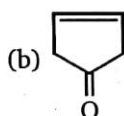
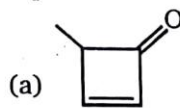
109. In sets a – d, only one of the set is incorrect regarding basic strength. Select it :

(a) $Ph-NH-Ph_1 < Ph-NH_2 <$ (cyclohexyl-NH_2) (strong base)

(b) N–H < N < H–N

(c) N–H > N–H > N, N

(d) NH_2 / NO_2 < NH_2 < NH_2 / CH_3

110. Dipole moment of which ketone is maximum ?

(a)
(b)
(c)
(d)

111. Correct order of basic strengths of given amines is :

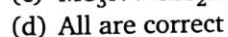
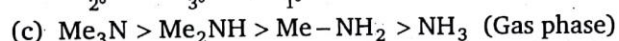
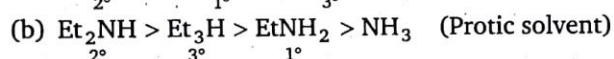
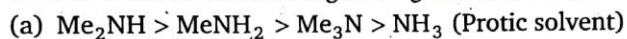
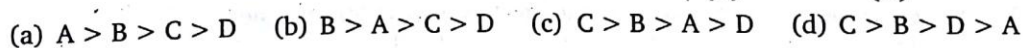
(a) $\underset{2°}{Me_2NH} > \underset{1°}{MeNH_2} > \underset{3°}{Me_3N} > NH_3$ (Protic solvent)

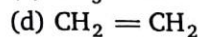
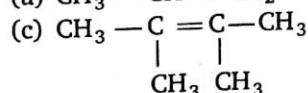
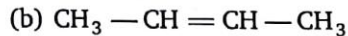
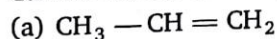
(b) $\underset{2°}{Et_2NH} > \underset{3°}{Et_3H} > \underset{1°}{EtNH_2} > NH_3$ (Protic solvent)

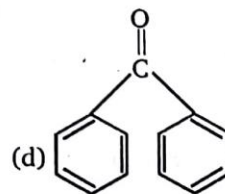
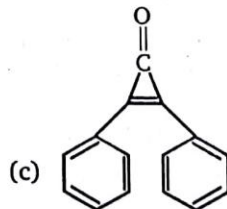
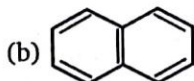
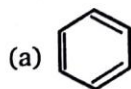
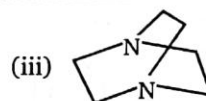
(c) $Me_3N > Me_2NH > Me-NH_2 > NH_3$ (Gas phase)

(d) All are correct

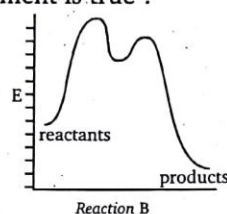
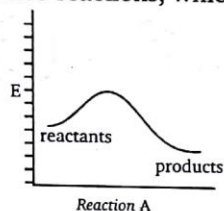
112. Order of basic strength $\underset{(A)}{Ph-NH_2}$, $\underset{(B)}{Ph-NH-Me}$, $\underset{(C)}{Ph-N(Me)-Me}$, (D) ($NH_2$, CH_3 on benzene ring)

(a) A > B > C > D (b) B > A > C > D (c) C > B > A > D (d) C > B > D > A

113. Carbon-carbon double bond length will be maximum in which of the following compounds ?

(a) $CH_3-CH=CH_2$
(b) $CH_3-CH=CH-CH_3$
(c) $CH_3-\underset{CH_3}{C}=\underset{CH_3}{C}-CH_3$
(d) $CH_2=CH_2$

114. Which has maximum dipole moment ?

(a)
(b)
(c)
(d)

115. (i) Et_3N (ii) (iii)

Compare the basic strengths of compounds given:

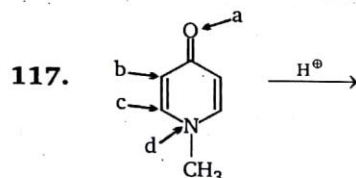
(a) (i) > (ii) > (iii) (b) (ii) > (i) > (iii) (c) (ii) > (iii) > (i) (d) (iii) > (ii) > (i)

116. For the following two reactions, which statement is true ?

(a) Reaction *A* is faster and less exergonic than *B*

(b) Reaction *B* is faster and more exergonic than *A*

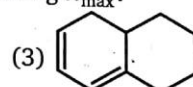
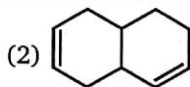
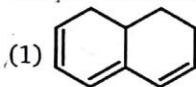
(c) Reaction *A* is faster and less endergonic than *B*

(d) Reaction *B* is faster and more endergonic than *A*

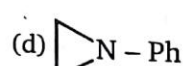
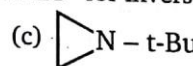
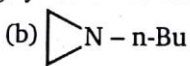
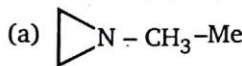
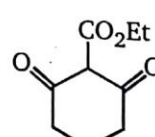
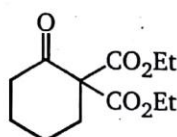
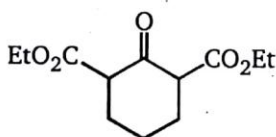
117.

Identify the site, where attack of H^+ is most favourable.

(a) *a* (b) *b* (c) *c* (d) *d*

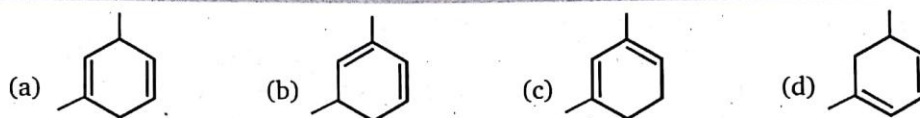
118. Rank the following alkenes on order of increasing λ_{max}.

(1) (2) (3)

(a) 1 < 2 < 3 (b) 1 < 3 < 2 (c) 2 < 1 < 3 (d) 2 < 3 < 1

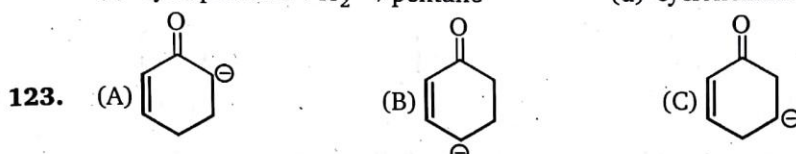
119. Which of the following cyclic amine has lowest $\Delta G^{\#}$ for inversion ?

(a) N – CH_3–Me (b) N – n-Bu (c) N – t-Bu (d) N – Ph

120. Rank in the order of increasing acidic strength:

(a) A < B < C (b) A < C < B (c) B < A < C (d) B < C < A

121. Which one of the following dienes would you expect to be the most stable ?

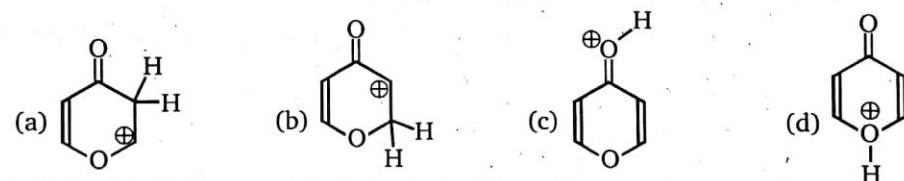
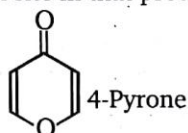
(a) (b) (c) (d)

122. Which metal catalyzed reaction would release the maximum amount of heat per CH_2 unit ?

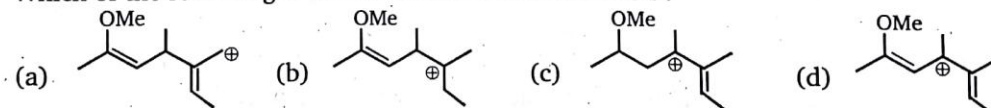
(a) cyclopropane + $H_2 \rightarrow$ propane (b) cyclobutane + $H_2 \rightarrow$ butane
(c) cyclopentane + $H_2 \rightarrow$ pentane (d) cyclohexane + $H_2 \rightarrow$ hexane

123.

Compare basic strengths of the above compounds:

(a) A > B > C (b) B > A > C (c) C > A > B (d) C > B > A

124. On reaction with acid, 4-pyrone gives a very stable cationic product. Which of the following structures shows the protonation site in that product ?

(a) (b) (c) (d)

125. Which of the following is the most stabilized carbocation ?

(a) (b) (c) (d)

126. Which carbocation is the most stable ?

(a) (b)

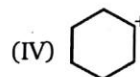
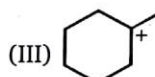
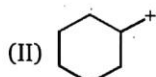
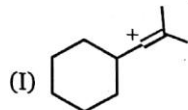
(c) (d)

127. Consider a positively charged C_2H_3 species in which the positively charged carbon is *sp*-hybridized, the uncharged carbon is sp^2-hybridized and an empty *p*-orbital is perpendicular to the π system. What it the best description of this cation ?

(a) vinyl (b) allenyl (c) alkyl (d) allyl

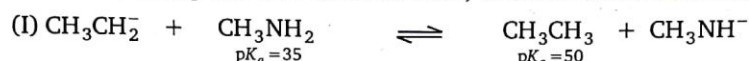
128. Which of the following reactions is not exothermic ?

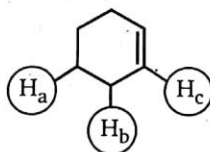
(a) $CH_3-Cl + CH_3-CH_3 \longrightarrow CH_4 + CH_3-CH_2-Cl$
(b) $CH_3-Cl + (CH_3)_3C-H \longrightarrow CH_4 + (CH_3)_3C-Cl$
(c) $CH_3-Cl + CH_2=CH-CH_3 \longrightarrow CH_4 + CH_2=CH-CH_2-Cl$
(d) $CH_3-Cl + CH_2=CH_2 \longrightarrow CH_4 + CH_2=CHCl$

129. List the following carbocations in order of decreasing stabilization energies.

(a) II, III, I, IV (b) III, IV, II, I (c) III, IV, I, II (d) I, II, IV, III

130. For the following two acid-base reactions, which statement is true ?

(I) $CH_3CH_2^- + \underset{pK_a=35}{CH_3NH_2} \rightleftharpoons \underset{pK_a=50}{CH_3CH_3} + CH_3NH^-$

(II) $F^- + \underset{pK_a=15.7}{H_2O} \rightleftharpoons \underset{pK_a=3.2}{HF} + HO^-$

(a) I is favoured to the right, II is favoured to the left
(b) I is favoured to the left, II is favoured to the right
(c) I is favoured to the right, II is favoured to the right
(d) I is favoured to the left, II is favoured to the left

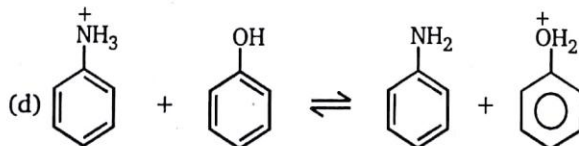
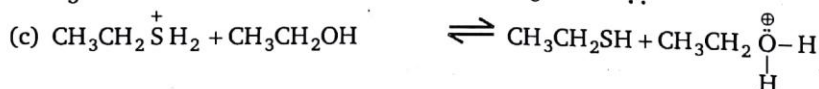
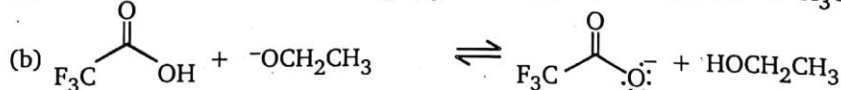
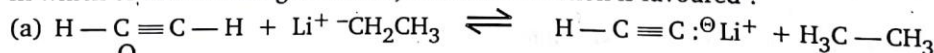
131. Rank the hydrogen atoms (H_a, H_b, H_c) in the following molecules according to their acidic strengths:

(a) $a > b > c$ (b) $b > a > c$ (c) $b > c > a$ (d) $a > c > b$

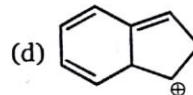
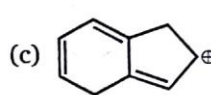
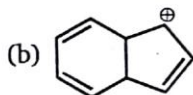
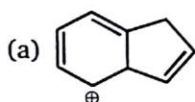
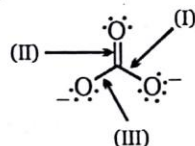
132. In which of the following reactions, backward reaction is favoured ?

(a) $H-C\equiv C-H + Li^{+}\,{}^{-}CH_2CH_3 \rightleftharpoons H-C\equiv C{:}^{\ominus}Li^{+} + H_3C-CH_3$

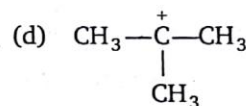
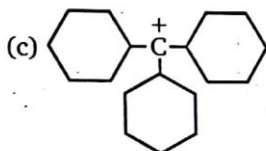
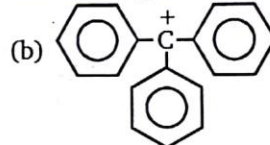
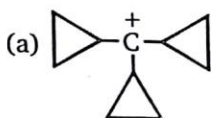
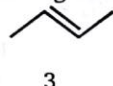
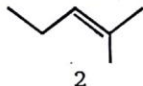
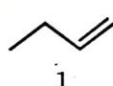
(b) $F_3C-C(=O)-OH + {}^{-}OCH_2CH_3 \rightleftharpoons F_3C-C(=O)-\ddot{O}{:}^{-} + HOCH_2CH_3$

(c) $CH_3CH_2\overset{+}{S}H_2 + CH_3CH_2OH \rightleftharpoons CH_3CH_2SH + CH_3CH_2\overset{\oplus}{\ddot{O}}(H)-H$

(d) $C_6H_5\overset{+}{N}H_3 + C_6H_5OH \rightleftharpoons C_6H_5NH_2 + C_6H_5\overset{+}{O}H_2$

133. Which carbocation is the most stabilized ?

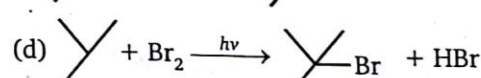
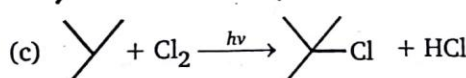
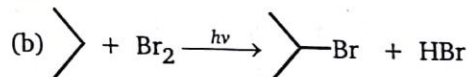
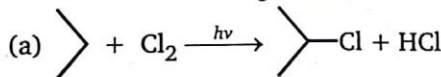
(a) (b) (c) (d)

134. Taking into account of hybridization and resonance effects, rank the following bonds in order of decreasing bond length.

(a) I > II = III (b) II > III > I (c) I > III > II (d) II = III = I

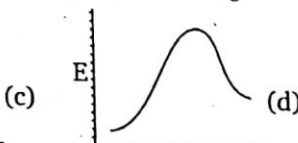
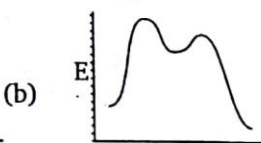
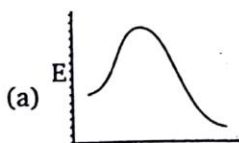
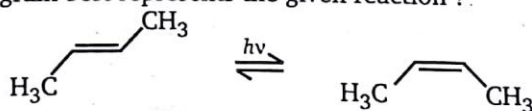
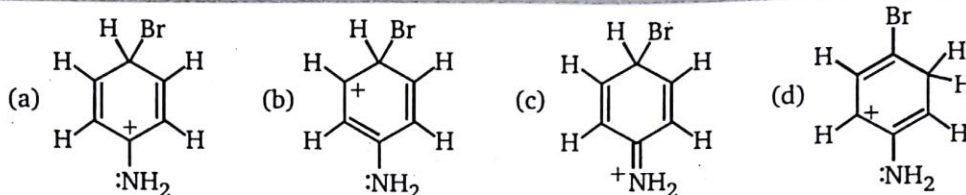
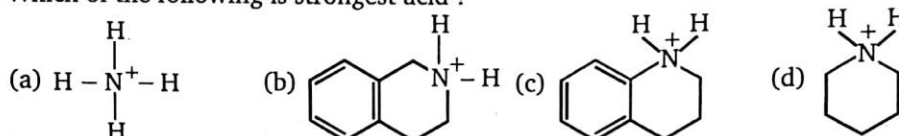
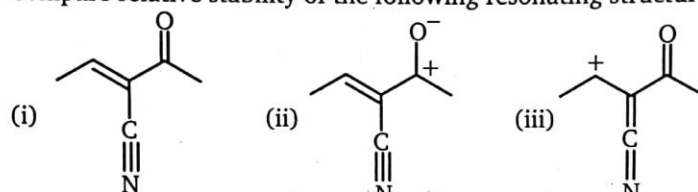
135. Which one among the following carbocations has the longest half-life ?

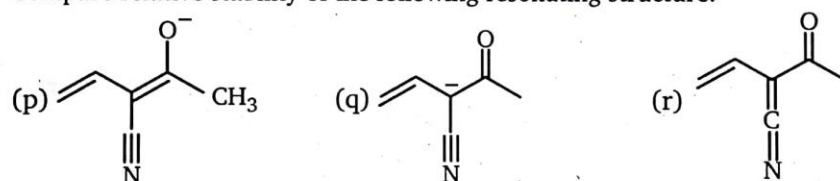
(a)
(b)
(c)
(d)

136. Rank the following alkenes in order of decreasing heats of hydrogenation (largest first)

(a) 2 > 3 > 4 > 1 (b) 2 > 4 > 3 > 1 (c) 1 > 3 > 4 > 2 (d) 1 > 4 > 3 > 2

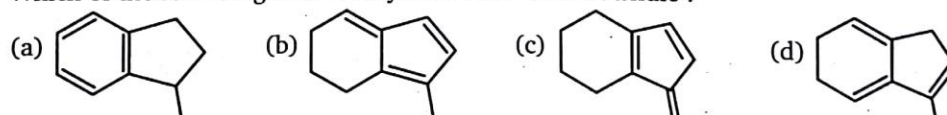
137. Which of the following reactions is most exothermic ?

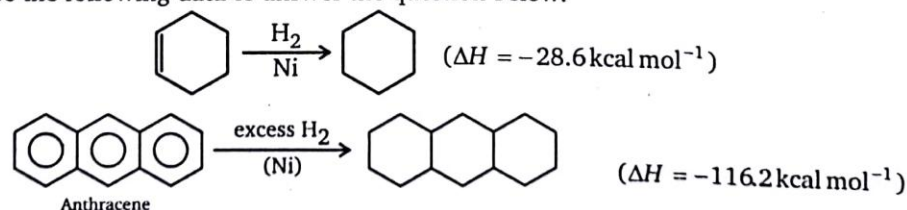
(a) + $Cl_2 \xrightarrow{h\nu}$ —Cl + HCl (b) + $Br_2 \xrightarrow{h\nu}$ —Br + HBr

(c) + $Cl_2 \xrightarrow{h\nu}$ —Cl + HCl (d) + $Br_2 \xrightarrow{h\nu}$ —Br + HBr

138. Which energy diagram best represents the given reaction ?

(a) (b) (c) (d)

139. Which one of the following is most stable ?

140. Which of the following is strongest acid ?

141. Compare relative stability of the following resonating structure.

(a) (i) > (ii) > (iii) (b) (ii) > (i) > (iii) (c) (i) > (iii) > (ii) (d) (ii) > (iii) > (i)

142. Compare relative stability of the following resonating structure.

(a) p > q > r (b) q > p > r (c) q > r > p (d) p > r > q

143. Which of the following isomeric hydrocarbons is most acidic ?

144. Which of the following has the lowest barrier to rotation about the indicated bond ?

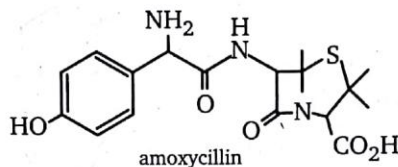
145. Use the following data to answer the question below.

Calculate the resonance energy of anthracene:

(a) 84 kcal/mol (b) 100 kcal/mol (c) 110 kcal/mol (d) 116 kcal/mol

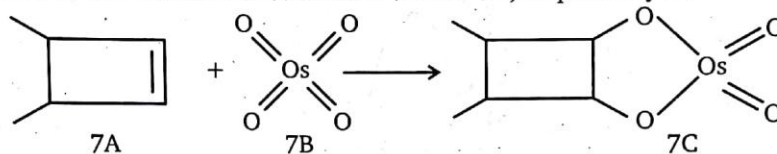
146. How many double bond equivalents does a compound of molecular formula $C_6H_{12}O_6$ possess?

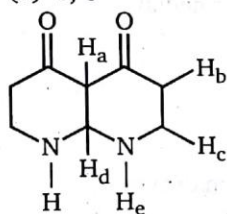
(a) 0 (b) 1 (c) 2 (d) 3

147. How many double bond equivalents does amoxycillin (shown below) possess ?

amoxycillin

(a) 5 (b) 6 (c) 7 (d) 9

148. What is the oxidation state of osmium in 7B and 7C, respectively ?

7A 7B 7C

(a) 6, 8 (b) 8, 6 (c) 6, 6 (d) 8, 8

149.

Identify most acidic hydrogen present in the above compound:

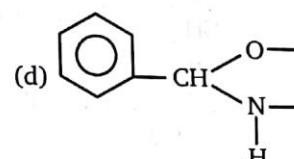
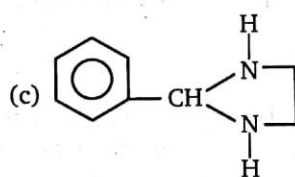
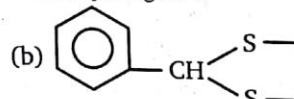
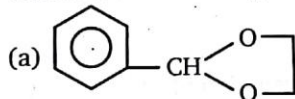
(a) *a* (b) *b* (c) *c* (d) *d*

150. Which of the following compounds has most acidic hydrogen ?

(a)

(b)

(c)

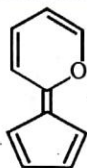
(d)

151. Acetic acid, (CH_3COOH), has a pK_a of 4.8. Ethanol, (CH_3CH_2OH), has a pK_a of 16.0. What are the major species present, when acetic acid and ethanol are added to water and the pH is adjusted to 7.0 ?

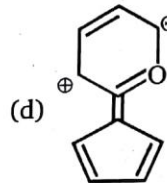
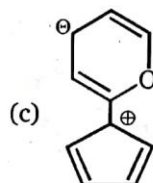
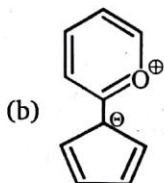
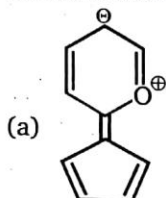
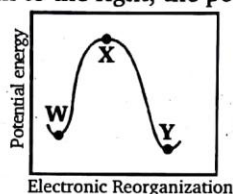
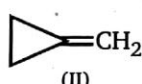
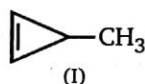
(a) CH_3CO_2H and CH_3CO_2OH

(b) $CH_3CH_2O^-$ and CH_3CH_2OH

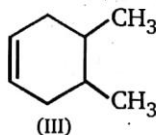
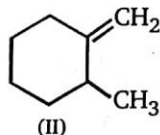
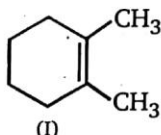
(c) CH_3CO_2H and $CH_3CH_2O^-$

(d) $CH_3CO_2^-$ and CH_3CH_2OH

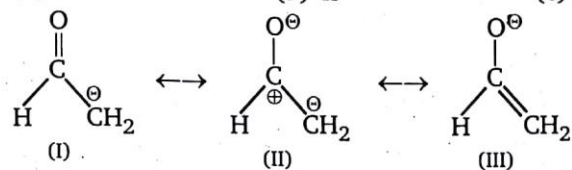
152.

The most stable canonical structure of given molecule is:

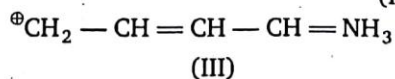
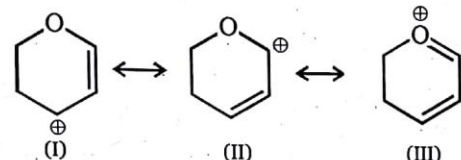
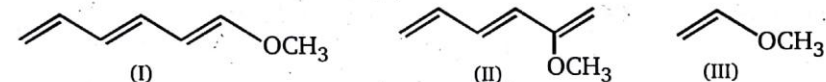
(a) (b) (c) (d)

153. In the potential energy diagram to the right, the point X represents :

(a) a transition state (b) a reaction intermediate
(c) a resonance hybrid (d) a reactant

154. (I) (II) (III)

Which of the following orders is correct for heat of hydrogenation of these compounds ?
(a) I > III > II (b) III > II > I (c) III > I > II (d) II > I > III

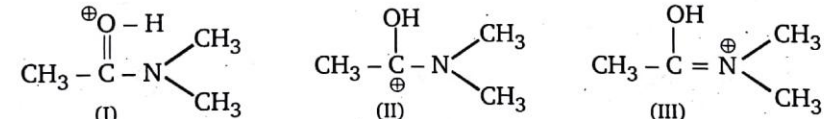
155. (I) (II) (III)

Which of the following orders is correct for heat of hydrogenation of these compounds ?
(a) I > II > III (b) III > II > I (c) II > III > I (d) III > I > II

156. $CH_2=O \longleftrightarrow {}^{\oplus}CH_2-O^{\ominus} \longleftrightarrow {}^{\ominus}CH_2-O^{\oplus}$
(I) (II) (III)

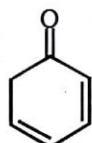
Which of these structures is practically not a valid canonical structure for formaldehyde ?
(a) I (b) II (c) III (d) None of these

157. $CH_2=CH-CH=CH-{}^{\oplus}NH_3$; (I) ${}^{\oplus}CH_2-CH=CH-{}^{\ominus}CH-{}^{\oplus}NH_3$ (II)

${}^{\oplus}CH_2-CH=CH-CH=NH_3$
(III)

Which of these structures is not a valid canonical structure ?

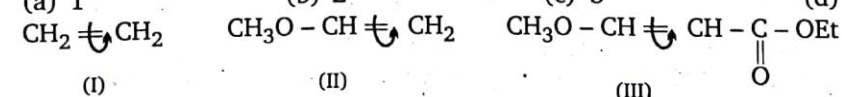
(a) I (b) II (c) III (d) none of these

158.

The correct order of stability for the given canonical structures is :

(a) I > III > II (b) III > I > II (c) II > III > I (d) II > I > III

159.

The most stable canonical structure among the given structure is :

(a) I (b) II (c) III (d) all are equally stable

160. OCH_3 (I)

For the given compounds the correct order of resonance energy is :

(a) III > I > II (b) II > I > III (c) I > II > III (d) III > II > I

161. $CH_3-C(=\overset{\oplus}{O}-H)-N(CH_3)_2$ (I)

$CH_3-C(OH)=\overset{\oplus}{N}(CH_3)_2$ (III)

The correct stability order of the given canonical structures is :

(a) I > II > III (b) III > I > II (c) I > III > II (d) II > III > I

162.

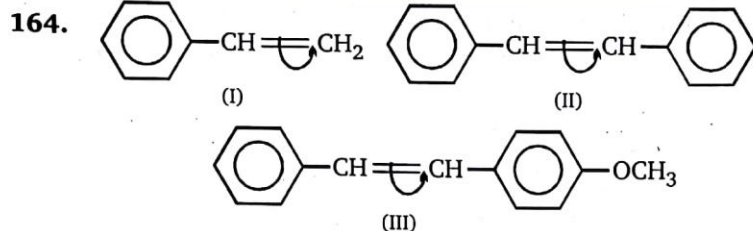
In the above compound, how many sites are available for the attack of CH_3O^- ?

(a) 1 (b) 2 (c) 3 (d) 4

163. $CH_2 = CH_2$ (I) $\quad CH_3O-CH=CH_2$ (II) $\quad CH_3O-CH=CH-C(=O)-OEt$ (III)

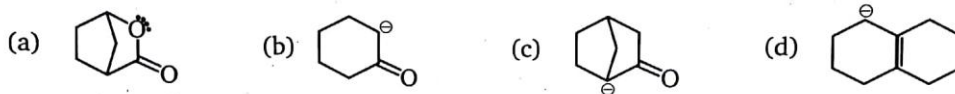
Which of the following orders of rotation barrier about the C = C bond, as indicated, is correct ?

(a) I > II > III (b) III > II > I (c) III > I > II (d) II > I > III

164. (I) C_6H_5—CH=CH$_2$ (II) C_6H_5—CH=CH—C_6H_5 (III) C_6H_5—CH=CH—C_6H_4—OCH_3 (p)

Which of the following orders of rotation barrier about the C = C bond, as indicated, is correct?

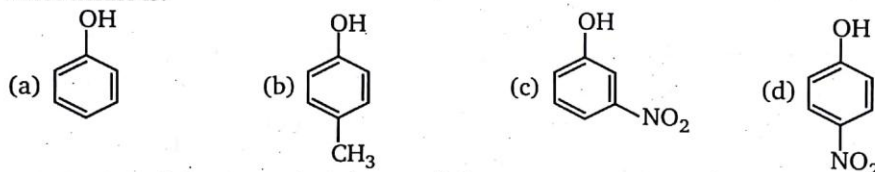
(a) I > II > III (b) III > II > I (c) III > I > II (d) II > I > III

165. Which of the following compound is not resonance stabilized ?

(a) (b) (c) (d)

166. Homologous compound have same:

(a) General formula (b) Emperical formula
(c) Structural formula (d) Molecular formula

167. Most acidic is:

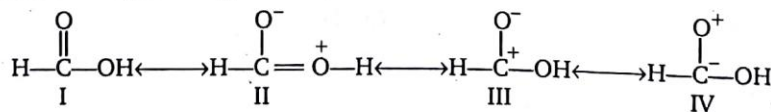
(a) Phenol (C$_6$H$_5$OH) (b) p-Cresol (OH and CH_3 para) (c) m-Nitrophenol (OH and NO_2 meta) (d) p-Nitrophenol (OH and NO_2 para)

168. Which of the following substituents will decrease the acidic strength of phenol?

(a) —NO_2 (b) —CN (c) —CH_3 (d) —CHO

169. Which of the following structures possesses a cross-conjugated system?

(a) $CH_2=CH-CH=CH-CH_2$
(b) $CH_2=CH-C(CH_2CH_3)=CH_2$
(c) $CH_2=CH-CH(CH=CH_2)-CH=CH_2$
(d) $CH_2=CH-C(CH=CH_2)=CH_2$

170. Examine the following resonating structures of formic acid for their individual stability and then answer the question given below.

$$\underset{I}{H-\overset{\overset{O}{\|}}{C}-OH} \longleftrightarrow \underset{II}{H-\overset{\overset{O^-}{|}}{C}=\overset{+}{O}-H} \longleftrightarrow \underset{III}{H-\overset{\overset{O^-}{|}}{\overset{+}{C}}-OH} \longleftrightarrow \underset{IV}{H-\overset{\overset{O^+}{|}}{\overset{-}{C}}-OH}$$

Which of the following arrangements gives the correct order of decreasing stability of the above-mentioned resonance contributors?

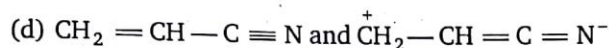
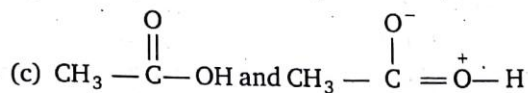
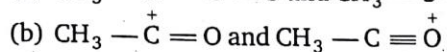
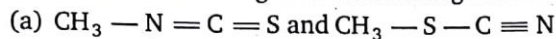
(a) II > I > III > IV (b) I > II > III > IV (c) IV > III > I > II (d) IV > III > I > II

171. Which of the following is not resonating structure of each other?

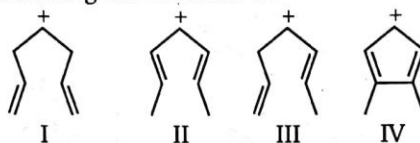
(a) $CH_3-N=C=S$ and $CH_3-S-C\equiv N$

(b) $CH_3-\overset{+}{C}=O$ and $CH_3-C\equiv\overset{+}{O}$

(c) $CH_3-\overset{O}{\overset{\|}{C}}-OH$ and $CH_3-\overset{O^-}{\overset{|}{C}}=\overset{+}{O}-H$

(d) $CH_2=CH-C\equiv N$ and $\overset{+}{C}H_2-CH=C=N^-$

172. In the molecule $CH_3C\equiv CCH=CH_2$, the maximum number of carbon atoms arranged linearly is:

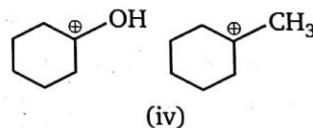
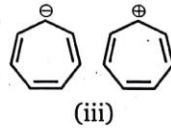
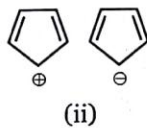
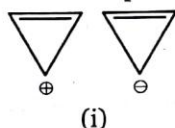
(a) 2 (b) 3 (c) 4 (d) 5

173. The stability order of the following carbocations is:

(a) II > IV > III > I (b) IV > II > III > I (c) II > III > I > IV (d) I > III > II > IV

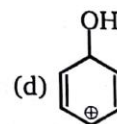
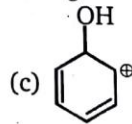
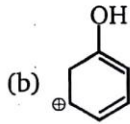
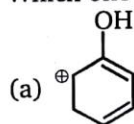
174. Total number of α-hydrogen in given compound is:

(a) 4 (b) 5 (c) 6 (d) 7

175. In which pair second ion is more stable than first?

(i) (ii) (iii) (iv)

(a) (i) and (ii) (b) (ii) and (iii) (c) (ii) and (iv) (d) (iii) and (iv)

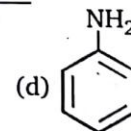
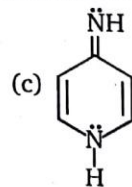
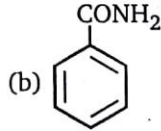
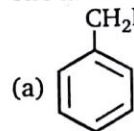
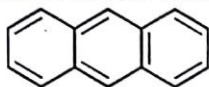
176. Which one is the most stable cation in the following ?

(a) (b) (c) (d)

177. The most reactive amine towards dilute hydrochloric acid is ________.

(a)

(b)

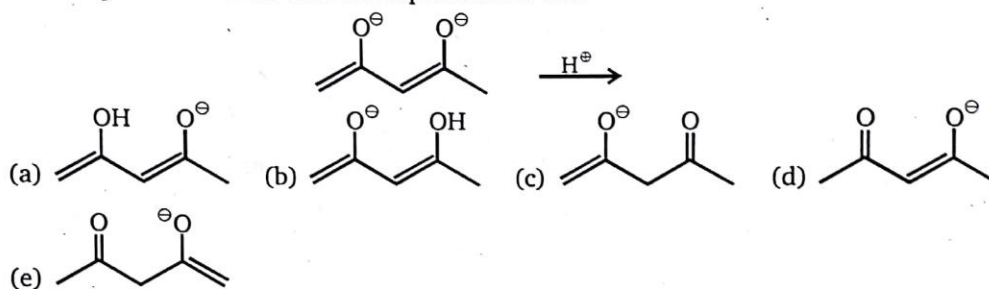
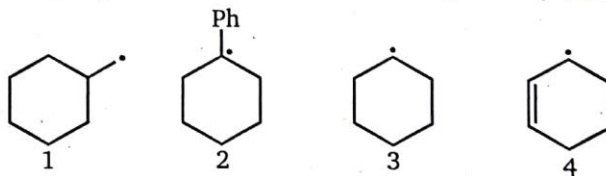
(c)

(d)

178. How many resonance structures are there for anthracene ?

(a) 6 (b) 5 (c) 4 (d) 2

179. Which base is strong enough to convert $(CH_3)_3COH$ into $(CH_3)_3CONa$ in a reaction that goes to completion ?

(a) $NaNH_2$ (b) CH_3CH_2Na (c) NaOH (d) CH_3CO_2Na

(e) More than one of the above

180. Based upon an understanding of product stability, predict the product formed when the following dianion reacts with one equivalent of acid

181. Rank the following alkyl radicals in order of increasing stability (least < < < most).

(a) $4 < 2 < 1 < 3$ (b) $3 < 1 < 2 < 4$ (c) $1 < 3 < 4 < 2$ (d) $2 < 4 < 3 < 1$

182. Among the given cations, the most stable carbonium ion is ?

(a) sec-butyl (b) tert-butyl (c) *n*-butyl (d) None of these

183. Cyclohexadiene contains ____ vinylic and _____ allylic hydrogen atoms ?

(a) 2 and 2 respectively (b) 4 and 4 respectively

(c) 2 and 4 respectively (d) 4 and 2 respectively

184. The dipole moments of halo compounds are in the order

(a) $CHCl_3 > CCl_4 > CHCl_2 >$ cis $- CHCl = CHCl$

(b) cis $- CHCl = CHCl > CHCl_3 > CH_2Cl > CCl_4$

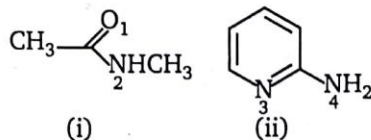
(c) cis $- CHCl = CHCl > CH_2Cl_2 > CHCl_3 > CCl$

(d) $CHCl_3 > CHCl_2 >$ cis $- CHCl = CHCl > CCl_4$

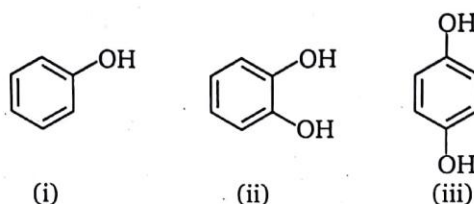
185. The pka value in H_2O of picric acid, acetic acid and phenol are in the order :

(a) Picric acid 0.4, acetic acid 4.75, phenol 10.0

(b) Acetic acid 0.4, picric acid 4.75, phenol 10.0
(c) Picric acid 0.4 phenol 4.75, acetic acid 10.0
(d) Phenol 0.4, acetic acid 4.75 picric acid 10.0

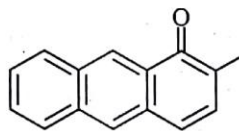
186. The preferred sites of protonation in the following compounds are:

(a) 1 and 3 (b) 2 and 4 (c) 1 and 4 (d) 2 and 3

187. Among i-iii

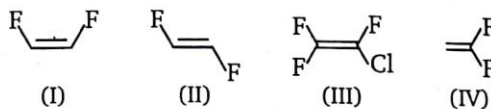
OH OH OH OH OH OH

(i) (ii) (iii)

the boiling point follows the order
(a) (ii) < (i) < (iii) (b) (iii) < (ii) < (i) (c) (i) < (ii) < (iii) (d) (ii) < (iii) < (i)

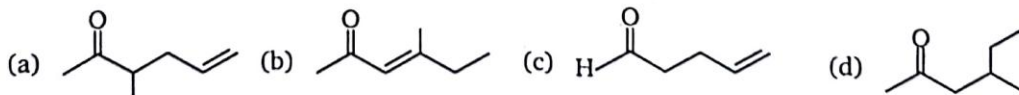
188. The number of C — C sigma bonds in the compound

O

(a) 16 (b) 14 (b) 18 (d) 11

189. The correct order of dipole moment for the following molecules is

F F F F F F F Cl F F

(I) (II) (III) (IV)

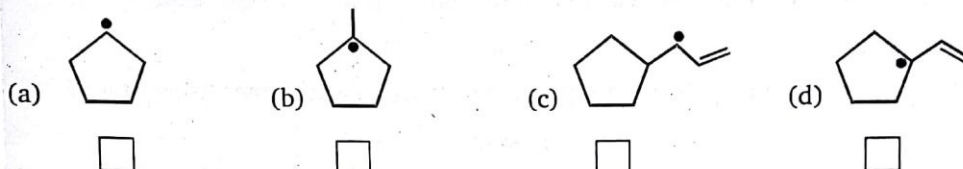
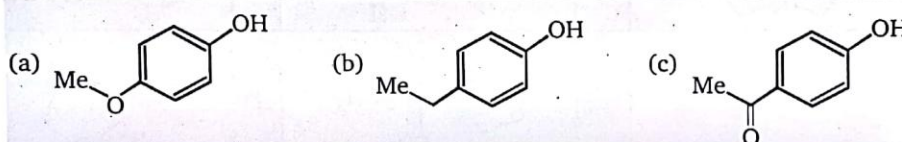
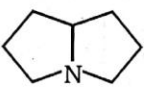
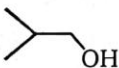
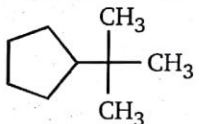
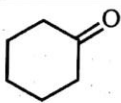
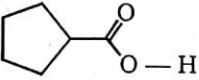
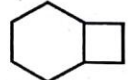
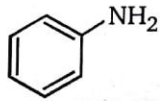
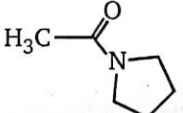
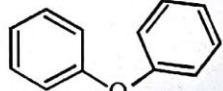
(a) IV > I > III > II (b) I > IV > III > II (c) III > I > II > IV (d) II > III > IV > I

190. Curved arrows are used in Organic Chemistry to show the movement of electrons in the mechanism of a reaction. The correct product of the following reaction is

ANSWERS — LEVEL 1

1.	(c)	**2.**	(d)	**3.**	(d)	**4.**	(a)	**5.**	(d)	**6.**	(d)	**7.**	(b)	**8.**	(c)
9.	(b)	**10.**	(c)	**11.**	(b)	**12.**	(b)	**13.**	(a)	**14.**	(b)	**15.**	(b)	**16.**	(b)
17.	(d)	**18.**	(c)	**19.**	(d)	**20.**	(d)	**21.**	(c)	**22.**	(c)	**23.**	(c)	**24.**	(a)
25.	(d)	**26.**	(d)	**27.**	(d)	**28.**	(a)	**29.**	(d)	**30.**	(a)	**31.**	(c)	**32.**	(c)
33.	(d)	**34.**	(d)	**35.**	(d)	**36.**	(d)	**37.**	(b)	**38.**	(b)	**39.**	(a)	**40.**	(c)
41.	(c)	**42.**	(d)	**43.**	(a)	**44.**	(c)	**45.**	(c)	**46.**	(d)	**47.**	(b)	**48.**	(d)
49.	(b)	**50.**	(b)	**51.**	(d)	**52.**	(d)	**53.**	(d)	**54.**	(a)	**55.**	(c)	**56.**	(c)
57.	(b)	**58.**	(b)	**59.**	(d)	**60.**	(c)	**61.**	(b)	**62.**	(b)	**63.**	(d)	**64.**	(c)
65.	(d)	**66.**	(c)	**67.**	(a)	**68.**	(a)	**69.**	(d)	**70.**	(b)	**71.**	(a)	**72.**	(d)
73.	(d)	**74.**	(d)	**75.**	(a)	**76.**	(d)	**77.**	(a)	**78.**	(a)	**79.**	(b)	**80.**	(a)
81.	(d)	**82.**	(d)	**83.**	(d)	**84.**	(c)	**85.**	(b)	**86.**	(a)	**87.**	(a)	**88.**	(b)
89.	(a)	**90.**	(d)	**91.**	(b)	**92.**	(c)	**93.**	(d)	**94.**	(d)	**95.**	(d)	**96.**	(d)
97.	(b)	**98.**	(d)	**99.**	(a)	**100.**	(b)	**101.**	(b)	**102.**	(d)	**103.**	(a)	**104.**	(a)
105.	(c)	**106.**	(c)	**107.**	(c)	**108.**	(b)	**109.**	(c)	**110.**	(c)	**111.**	(d)	**112.**	(c)
113.	(c)	**114.**	(c)	**115.**	(c)	**116.**	(a)	**117.**	(a)	**118.**	(d)	**119.**	(c)	**120.**	(c)
121.	(c)	**122.**	(a)	**123.**	(c)	**124.**	(c)	**125.**	(d)	**126.**	(b)	**127.**	(a)	**128.**	(d)
129.	(b)	**130.**	(a)	**131.**	(c)	**132.**	(d)	**133.**	(c)	**134.**	(d)	**135.**	(a)	**136.**	(d)
137.	(c)	**138.**	(d)	**139.**	(c)	**140.**	(c)	**141.**	(a)	**142.**	(d)	**143.**	(b)	**144.**	(c)
145.	(a)	**146.**	(b)	**147.**	(d)	**148.**	(b)	**149.**	(a)	**150.**	(b)	**151.**	(d)	**152.**	(b)
153.	(a)	**154.**	(a)	**155.**	(c)	**156.**	(c)	**157.**	(c)	**158.**	(b)	**159.**	(c)	**160.**	(c)
161.	(b)	**162.**	(c)	**163.**	(a)	**164.**	(a)	**165.**	(c)	**166.**	(a)	**167.**	(d)	**168.**	(c)
169.	(d)	**170.**	(b)	**171.**	(a)	**172.**	(c)	**173.**	(c)	**174.**	(c)	**175.**	(b)	**176.**	(b)
177.	(c)	**178.**	(c)	**179.**	(e)	**180.**	(d)	**181.**	(c)	**182.**	(b)	**183.**	(b)	**184.**	(c)
185.	(a)	**186.**	(a)	**187.**	(a)	**188.**	(b)	**189.**	(b)	**190.**	(c)				

LEVEL-2

1. Rank in order of radical stability (1 = most stable).

(a) ☐ (b) ☐ (c) ☐ (d) ☐

2. Predict the acidity order for the three phenols shown below :
Acidity order : 1 (most) to 3 (least)

Acidity order : ....

3. Comprehension

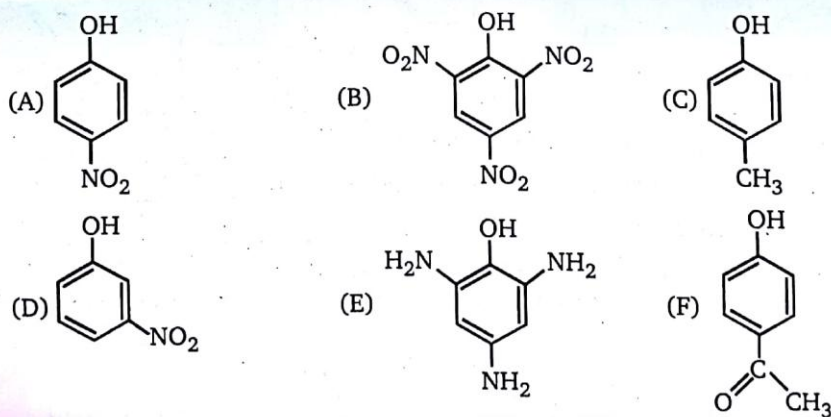
(A) OH, NO_2

(B) OH, O_2N, NO_2, NO_2

(C) OH, CH_3

(D) OH, NO_2

(E) OH, H_2N, NH_2, NH_2

(F) OH, O, C, CH_3

A. Which of the phenol derivatives above is the strongest acid ?

☐ Compound A ☐ Compound B ☐ Compound C
☐ Compound D ☐ Compound E ☐ Compound F

B. Which of the phenol derivatives above is the weakest acid ?

☐ Compound A ☐ Compound B ☐ Compound C
☐ Compound D ☐ Compound E ☐ Compound F

C. Which of the mono-nitrophenol derivatives above is the strongest acid ?

☐ Compound A ☐ Compound D

D. Which of the carbon-substituted phenol derivatives above is the strongest acid ?

☐ Compound C ☐ Compound F

4. The following questions refer to the twelve compounds given below. You may enter as many as six choices in each answer box.

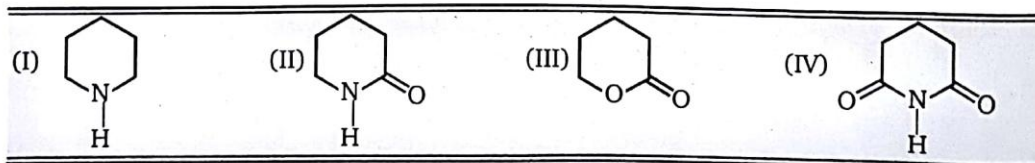
(a)	N	**(b)**	OH	**(c)**	H_3C—C(=O)—O—C_2H_5
(d)	H—F	**(e)**	CH_3, CH_3, CH_3	**(f)**	O
(g)	O	**(h)**	O, O—H	**(i)**	
(j)	NH_2	**(k)**	H_3C—C(=O)—N	**(l)**	O

A. Which compound may serve only as H-bond acceptors ? ☐

B. Which may serve both as H-bond donors and acceptors? ☐

C. Which compounds will not participate in H-bonding ? ☐

5. Consider the following compounds and answer A and B.

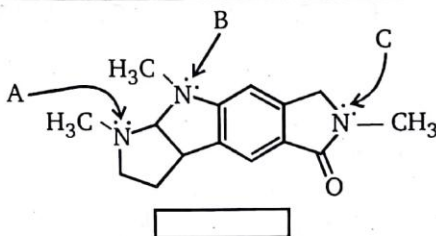
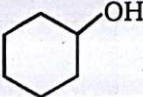
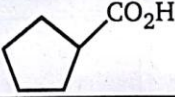
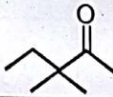
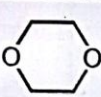
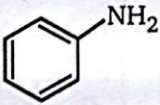
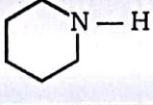
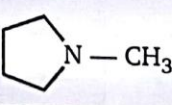
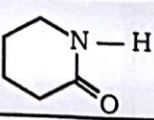
(I) N–H (II) N–H, O (III) O, O (IV) O, N–H, O

A. Which of the compounds is the strongest Bronsted acid ?

(a) I (b) II (c) III (d) IV

B. Which of the compounds is the strongest Lewis base ?

(a) I (b) II (c) III (d) IV

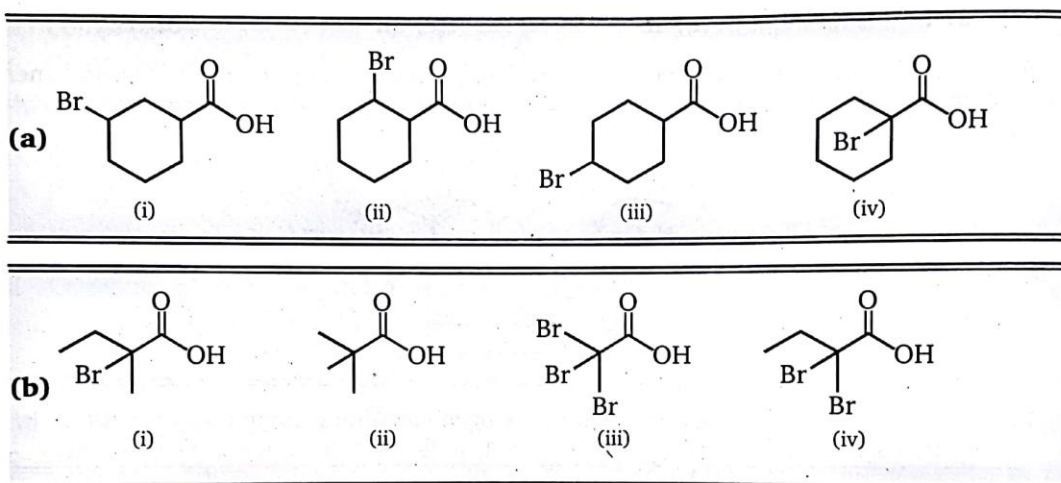
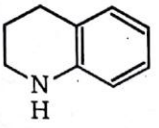
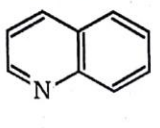
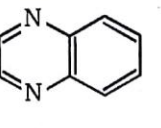
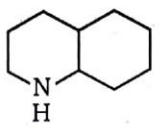
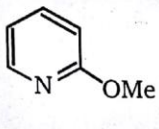
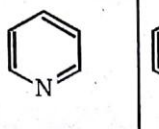
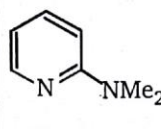
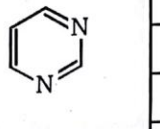
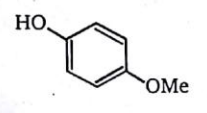
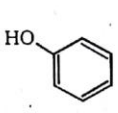
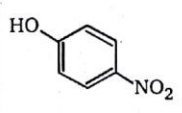
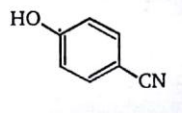
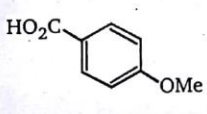
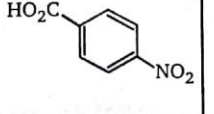
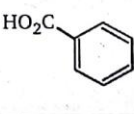
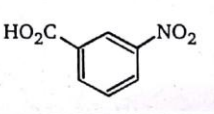
6. Rank the non-bonding electrons indicated by the arrows in order of increasing energy.

A, B, C; H_3C, H_3C–N, N, N — CH_3, O

7. In each of the following sections four nitrogen containing compounds are listed. In the box under each formula write a number (1 to 4) indicating the order of base strength.

(a)	N	N — CH_3	N — H, O	O_2N — NH_2
(b)	N — H	NH_2	O_2N — NH_2	O, N — H, O
(c)	$N(CH_3)_2$	N — H	N — H, N — H, N–H	N — CH_3
(d)	H_3C, H_3C >— C ≡ N	N	N — H	N — H

8. For the two sets of acids shown below, rank their acidity most acidic to least acidic.

(a) (i) (ii) (iii) (iv)

(b) (i) (ii) (iii) (iv)

9. In each of the following sections four compounds are listed. In the box under each formula enter a number (1 to 4) indicating the order of acid strength (1 is strongest & 4 is weakest).

(a)	$CH_3CH_2CH_2CO_2H$	$CH_3CH_2CHBrCO_2H$	$ClCH_2CH_2CH_2CO_2H$	$CH_3CCl_2CO_2H$
(b)	$C_6H_5CH_2OH$	$C_6H_5CO_2H$	$C_6H_5OCH_3$	C_6H_5OH
(c)	OH	CO_2H	O	O O
(d)	NH_2	N — H	N — CH_3	N — H, O

10. In the two questions below, you are asked to rank the relative strengths of illustrated acids and bases. Use your knowledge of resonance and inductive to answer this.

A. For the series of bases shown below, rank the set from strongest to weakest.

	(a)	(b)	(c)	(d)		
(i)	N-H	N	N, N	N-H		Strongest ... Weakest
(ii)	N, OMe	N	N, NMe_2	N, N		Strongest ... Weakest

B. For the series of acids shown below, rank the set from strongest to weakest.

	(a)	(b)	(c)	(d)		
(i)	HO, OMe	HO	HO, NO_2	HO, CN		Strongest ... Weakest
(ii)	HO_2C, OMe	HO_2C, NO_2	HO_2C	HO_2C, NO_2		Strongest ... Weakest

11. In each of the following sections four compounds are listed. (Decreasing order of acidic strength, 1 is strongest & 4 is weakest).

(a)	$CH_2(CO_2C_2H_5)_2$	$CH_3COCH_2CO_2C_2H_5$	$(CH_3CO)_2CH_2$	$RC \equiv CH$
(b)	RCH_2NO_2	RSO_2CH_3	$(C_6H_5)_3CH$	$RCOCH_3$
(c)	$CH_2(C \equiv N)_2$	$CH_2(NO_2)_2$	$HC \equiv N$	$RCH_2CO_2C_2H_5$

(d)	CH_2	CH_2 ;	S S CH_2	O CH_2 O

12. Rank in the order of increasing basic strength.

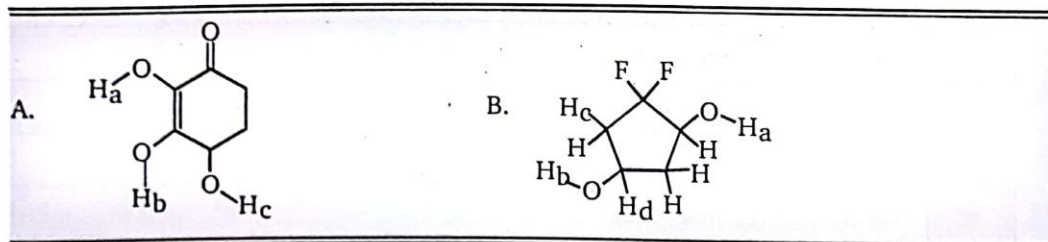
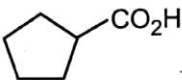
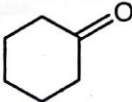
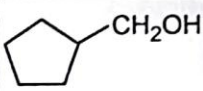
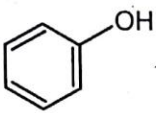
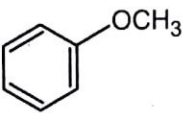
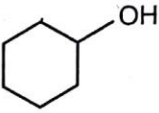
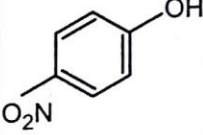
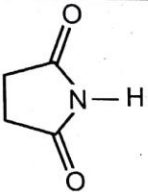
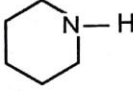
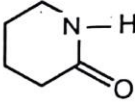
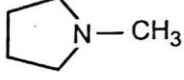
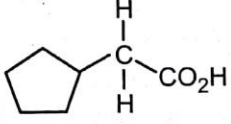
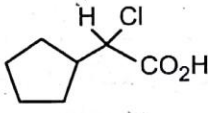
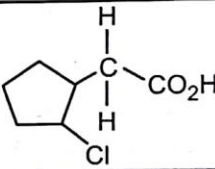
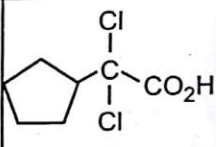
13. Compare acidic strength of the following (Write your answer in box).

A.	OH	OH	OH		
	(a)	(b)	(c)		
B.	H_2N OH	H_3CO OH	OH F_3C		
	(a)	(b)	(c)		

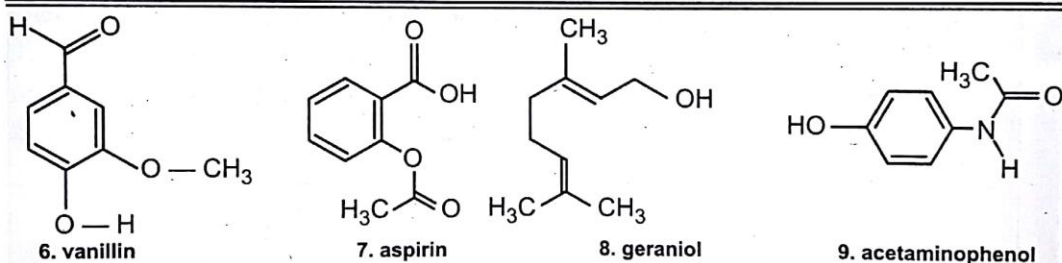
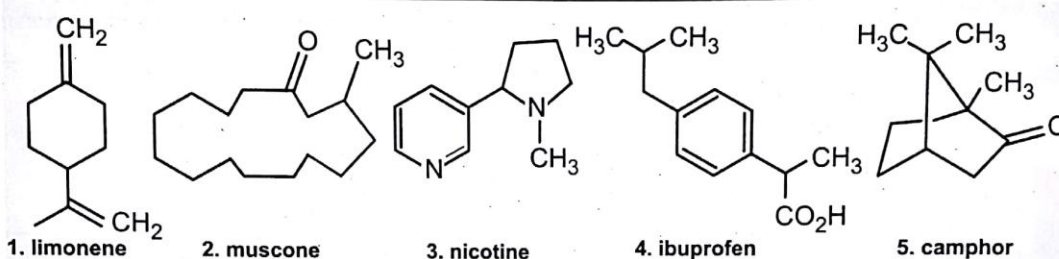
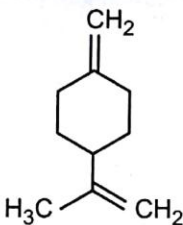
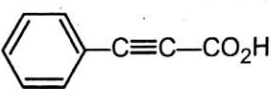
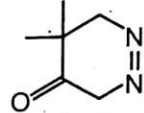
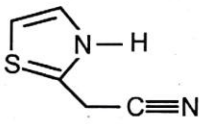
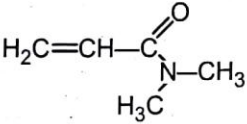
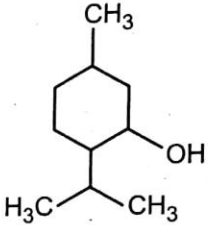
C.	Cl, Br, OH, F	Cl, F, OH, Br	F, Cl, OH, Br	
	(a)	(b)	(c)	
D.	O, O	O, O	O, O	O, O
	(a)	(b)	(c)	(d)
E.	O, O, O	O, O, O	O, O, O	
	(a)	(b)	(c)	
F.	H	H	H	
	(a)	(b)	(c)	

14. Arrange the hydrogens in increasing order of their acidic strengths.

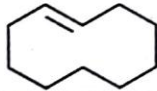
A. O, Ha, O, Hb, O, Hc

B. F, F, Hc, O, Ha, H, H, H, Hb, O, Hd, H

15. The compounds whose structures are shown below, incorporate a variety of functional groups. The question on the right ask you to identify which compounds have a specific functional group. For each compound that has the designed group, enter the appropriate number. The aromatic rings should not be counted as double bonds.

1. limonene 2. muscone 3. nicotine 4. ibuprofen 5. camphor

6. vanillin 7. aspirin 8. geraniol 9. acetaminophenol

A.	Which have carbon-carbon double bonds ?	
B.	Which have a ketone carbonyl group ?	
C.	Which have an aldehyde carbonyl group ?	
D.	Which have aromatic rings ?	
E.	Which have a hydroxy group ?	
F.	Which have ether groups ?	
G.	Which have an ester group ?	
H.	Which have an amide group ?	
I.	Which have a carboxylic acid group ?	

16.

Problem	A	B	C	D
1	O	CO_2H	O	CH_2OH
2	OH	OCH_3	OH	OH, O_2N
3	O, N—H, O	N—H	N—H, O	N—CH_3
4	H, C, H, CO_2H	H, Cl, CO_2H	H, C, H, CO_2H, Cl	Cl, C, Cl, CO_2H

A. Which is the strongest acid in 1?
(a) A (b) B (c) C (d) D

B. Which is weakest acid in 1 ?
(a) A (b) B (c) C (d) D

C. Which is the strongest acid in 2 ?
(a) A (b) B (c) C (d) D

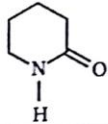
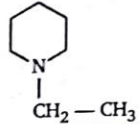
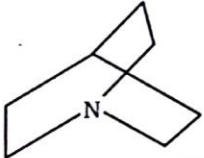
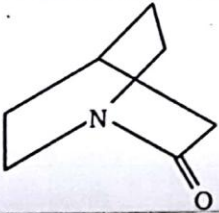
D. Which is weakest acid in 2 ?
(a) A (b) B (c) C (d) D

E. Which is the strongest acid in 3 ?
(a) A (b) B (c) C (d) D

F. Which is weakest acid in 3 ?
(a) A (b) B (c) C (d) D

G. Which is the strongest acid in 4 ?
(a) A (b) B (c) C (d) D

H. Which is weakest acid in 4 ?
(a) A (b) B (c) C (d) D

17. For each of the six structural formulae (**A** through **F**), shown below, five questions are posed. The answer to each is a number that should be entered in the appropriate answer box.

CH_2 / H_3C CH_2	$-C\equiv C-CO_2H$	N / N / O
A	**B**	**C**
N—H / S / C≡N	$H_2C=CH-C$ O / N—CH_3 / H_3C	CH_3 / OH / H_3C CH_3
D	**E**	**F**

A. (i) Number of sp^3 carbons : ....

(ii) Number of sp^2 carbons : ....

(iii) Number of sp carbons : ....

(iv) Number of carbon-carbon σ-bonds : ....

(v) Number of π-bonds to carbon : ....

B. Number of sp^3 carbons : ....

Number of sp^2 carbons : ....

Number of sp carbons : ....

Number of carbon-carbon σ-bonds : ....

Number of π-bonds to carbon : ....

C. Number of sp^3 carbons : ....

Number of sp^2 carbons : ....

Number of sp carbons : ....

Number of carbon-carbon σ-bonds : ....

Number of π-bonds to carbon :......................

D. (i) Number of sp^3 carbons : ....

(ii) Number of sp^2 carbons : ....

(iii) Number of sp carbons : ....

(iv) Number of carbon-carbon σ-bonds : ....

(v) Number of π-bonds to carbon : ....

E. Number of sp^3 carbons : ....

Number of sp^2 carbons : ....

Number of sp carbons : ....

Number of carbon-carbon σ-bonds : ....

Number of π-bonds to carbon :..............

F. Number of sp^3 carbons : ....

Number of sp^2 carbons : ....

Number of sp carbons : ....

Number of carbon-carbon σ-bonds : ....

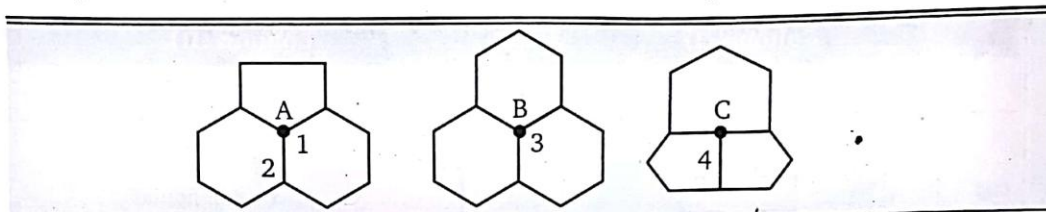
Number of π-bonds to carbon :..............

18. Match the column (I) and (II). (Matrix)

Column (I)		Column (II)	
	Molecule		Property
(a)		(p)	*cis*-compound
(b)		(q)	*trans*-compound
(c)		(r)	Highest heat of combustion
(d)		(s)	lowest heat of combustion

19. Match the column (I) and (II).

Column (I)		Column (II)	
	Molecule		pK_a of Conjugate acid
(a)	N, O, H	(p)	0.8
(b)	N, CH_2-CH_3	(q)	5.33
(c)	N	(r)	10.65
(d)	N, O	(s)	10.95

20. The junctures centred on atoms A, B and C on the given structure.

A. Which juncture has the greatest deviation from planarity ?

(a) A (b) B (c) C (d) Cannot be predicted

B. Of the carbon-carbon bonds, (shown above) numbered from 1 to 4, which represent the most favourable site for H_2 addition ?

(a) 1 (b) 2 (c) 3 (d) 4

21. Select the most stable structure in each of the following

Part (C)

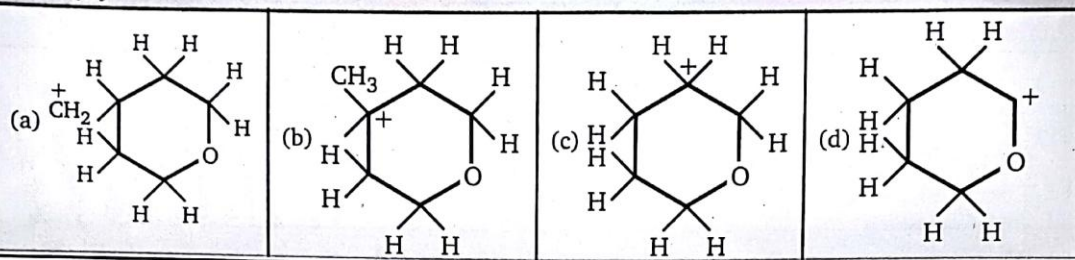
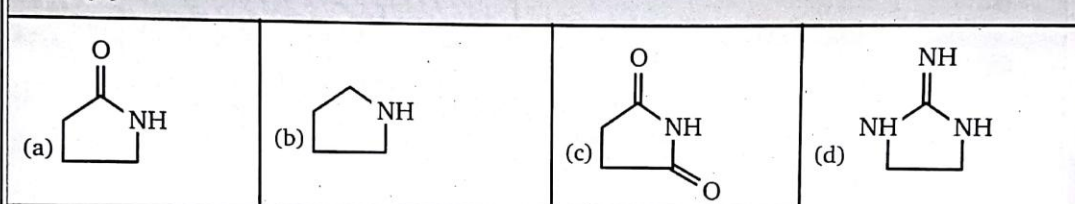
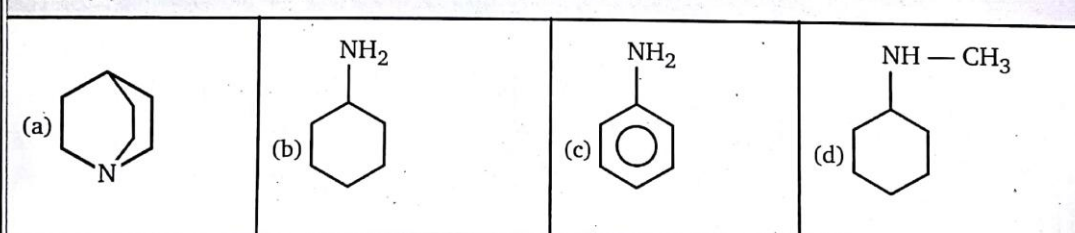
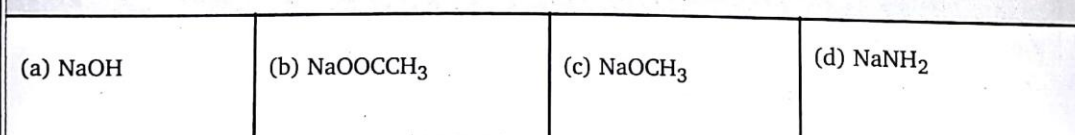
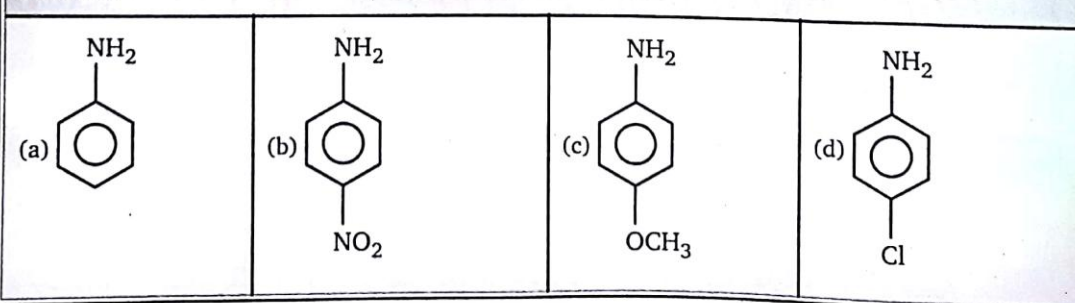
(a) $H_2C=CH-CH=CH-CH_3$	(b) $H_2C=C=CH-CH_2-CH_3$
(c) $H_3C-CH=C=CH-CH_3$	(d) $H_2C=CH-CH_2-CH=CH_2$

22. Match the column I and II. (Matrix)

	Column (I)		Column (II)
(a)	$-NO_2$	**(p)**	$-m$ effect
(b)	$-O^-$	**(q)**	$+m$ effect
(c)	$-O-CH_3$	**(r)**	$+I$ effect
(d)	$-C\equiv N$	**(s)**	$-I$ effect

23. Match the column I and II. (Matrix)

	Column (I)		Column (II)
(a)	$H_3C-CH=CH-CH_3$	**(p)**	Dipole (*cis* > *trans*)
(b)	$H_3C-CH=CH-CN$	**(q)**	Dipole (*trans* > *cis*)
(c)	$H_3C-CH=CH-Cl$	**(r)**	Melting point ((*trans* > *cis*)
(d)	$Cl-CH=CH-Cl$	**(s)**	Boiling point (*cis* > *trans*)

24. Identify the most stable structure in each of the following :

25. Identify the most basic compound in the following.

26. Identify the most acidic hydrogen containing compound from the following.

Part (F)

(a) CH_3CH_2OH	(b) $CH_3CH_2NH_2$	(c) $CH_3-C\equiv CH$	(d) $CH_3-CH=CH_2$

Part (G)

(a) CH_3-CO_2H	(b) CH_2-CO_2H with $\overset{\oplus}{N}H_3$ on CH_2	(c) $\overset{+}{N}H_3$ on benzene ring	(d) $\overset{+}{N}H_3$ on cyclohexane ring

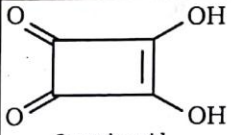
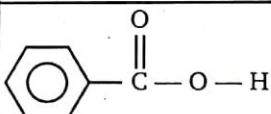
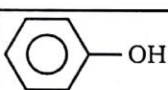
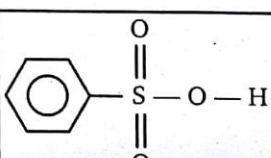
Part (H)

(a) OH, NO_2, NO_2	(b) OH, NO_2	(c) OH, NO_2, NO_2	(d) OH, NO_2

Part (I)

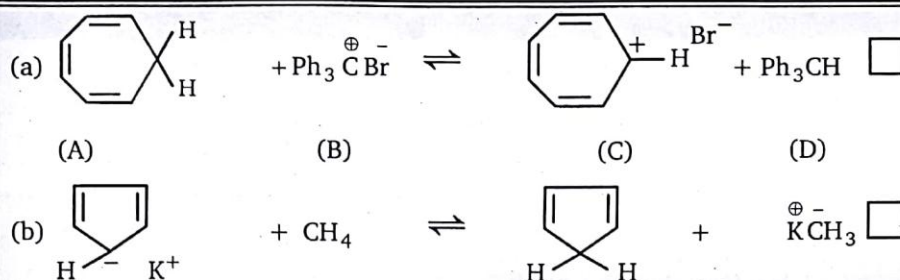
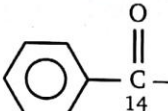
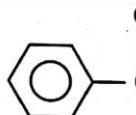
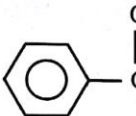
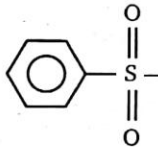
CH (a)	(b)	CH (c)	(d)

27.

$$N\equiv C^1-C^2(=O^1)-CH_2-C^3H_3$$

Give the type of hybridization present at each atom.

(i) N —.................. (ii) C_1 —.................. (iii) C_2 —..................

(iv) O_1 —.................. (v) CH_2 —.................. (vi) C_3 —..................

28. Predict the direction of the following equilibrium. Write your answer in the box given below.

29. Match the column I and II. (Matrix)

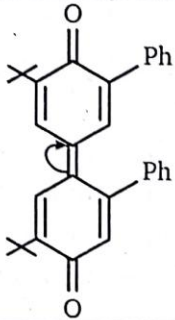
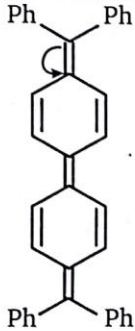
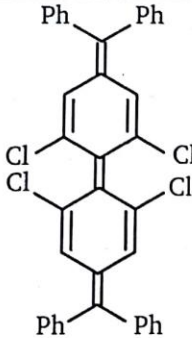
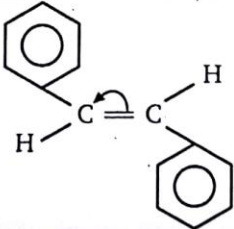
	Column (I)		Column (II)
(a)	$NaHCO_3$ will react with	**(p)**	Squaric acid (O, O, OH, OH)
(b)	Na will react with	**(q)**	$C_6H_5-\overset{O}{\overset{\Vert}{C}}-O-H$
(c)	NaOH will react with	**(r)**	C_6H_5-OH
(d)	$NaNH_2$ will react with	**(s)**	$C_6H_5-\underset{O}{\underset{\Vert}{\overset{O}{\overset{\Vert}{S}}}}-O-H$

30. Match the column I and II.

	Column (I) Acid		Column (II) pK_a
(a)	CH_3-CO_2H	**(p)**	5.69
(b)	$(CH_3)_3\overset{\oplus}{N}CH_2CO_2H$	**(q)**	4.27
(c)	$(CH_3)_3\overset{\oplus}{N}(CH_2)_4CO_2H$	**(r)**	1.83
(d)	$\bar{O}_2C-CH_2-CO_2H$	**(s)**	4.80

31. Match the column I and II.

	Column (I)		Column (II)
(a)	$C_6H_5-\overset{O}{\overset{\|\|}{\underset{14}{C}}}-O-H + NaHCO_3 \longrightarrow$	**(p)**	NH_3
(b)	$C_6H_5-\overset{O}{\overset{\|\|}{C}}-O-H + NaH\overset{14}{C}O_3 \longrightarrow$	**(q)**	$\overset{14}{C}O_2$
(c)	$C_6H_5-\overset{O}{\overset{\|\|}{C}}-O-H + Na \longrightarrow$	**(r)**	$\dot{C}O_2$
(d)	$C_6H_5-S(=O)_2-O-H + NaNH_2 \longrightarrow$	**(s)**	H_2

32. (Naphthalene bearing SO_3H, CO_2H, OH and $CH(OH)-C\equiv CH$ groups) $\xrightarrow{NaH\overset{14}{C}O_3} \underset{gas}{(A)} + (B) \xrightarrow{NaHCO_3} \underset{gas}{(C)} + (D)$

Sum of molecular mass of gas $(A + C)$ is :

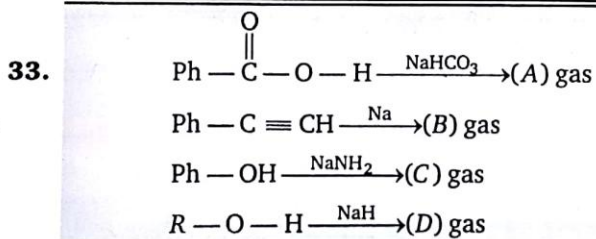
(a) 88 (b) 90 (c) 92 (d) 40

33.

$Ph-\overset{O}{\overset{\|\|}{C}}-O-H \xrightarrow{NaHCO_3} (A)$ gas

$Ph-C\equiv CH \xrightarrow{Na} (B)$ gas

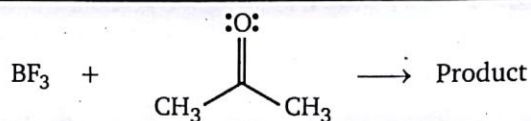
$Ph-OH \xrightarrow{NaNH_2} (C)$ gas

$R-O-H \xrightarrow{NaH} (D)$ gas

Sum of molecular mass of gas $A + B + C + D$ is :

34. Match the column I and II.

Column (I)		Column (II)	
Molecule		Rotational free energy barrier	
(a)	O, Ph, Ph, O	(p)	180 kJ/mol
(b)	Ph, Ph, Ph, Ph	(q)	88.3 kJ/mol
(c)	Ph, Ph, Cl, Cl, Cl, Cl, Ph, Ph	(r)	21 kJ/mol
(d)	H, C, C, H	(s)	Negative barrier

35. Consider the following reaction of boron trifluoride (BF_3) and acetone :

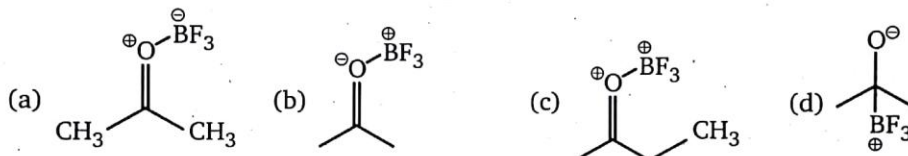
BF_3 + $CH_3C(=O)CH_3$ ⟶ Product

A. What is the critical HOMO (nucleophile) of this reaction ?

(a) non-bonding orbital on boron
(b) σ-orbital of acetone
(c) π-orbital of acetone
(d) non-bonding electron pair orbital on oxygen

B. What is the critical LUMO (electrophile) of the reaction ?

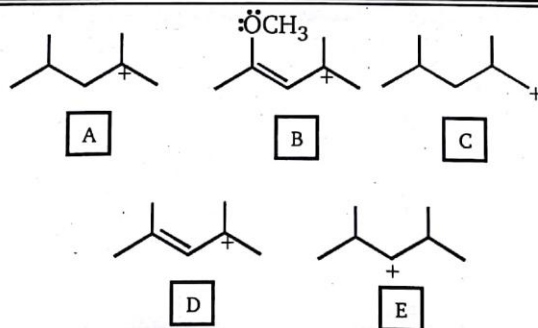
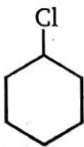
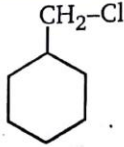
(a) *p*-orbital of BF_3
(b) σ-orbital of BF_3
(c) π* orbital of acetone
(d) non-bonding electron pair orbital on oxygen

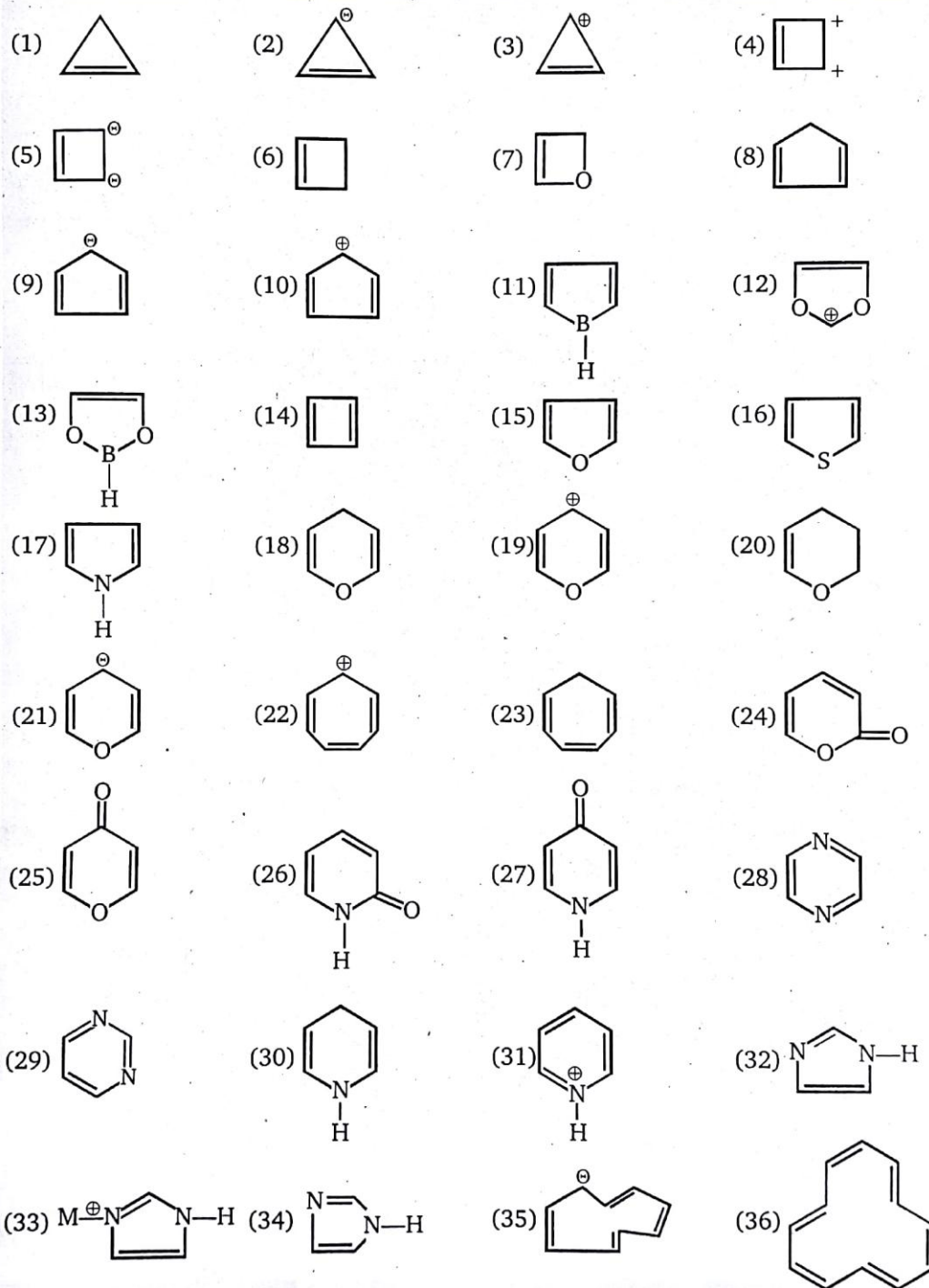
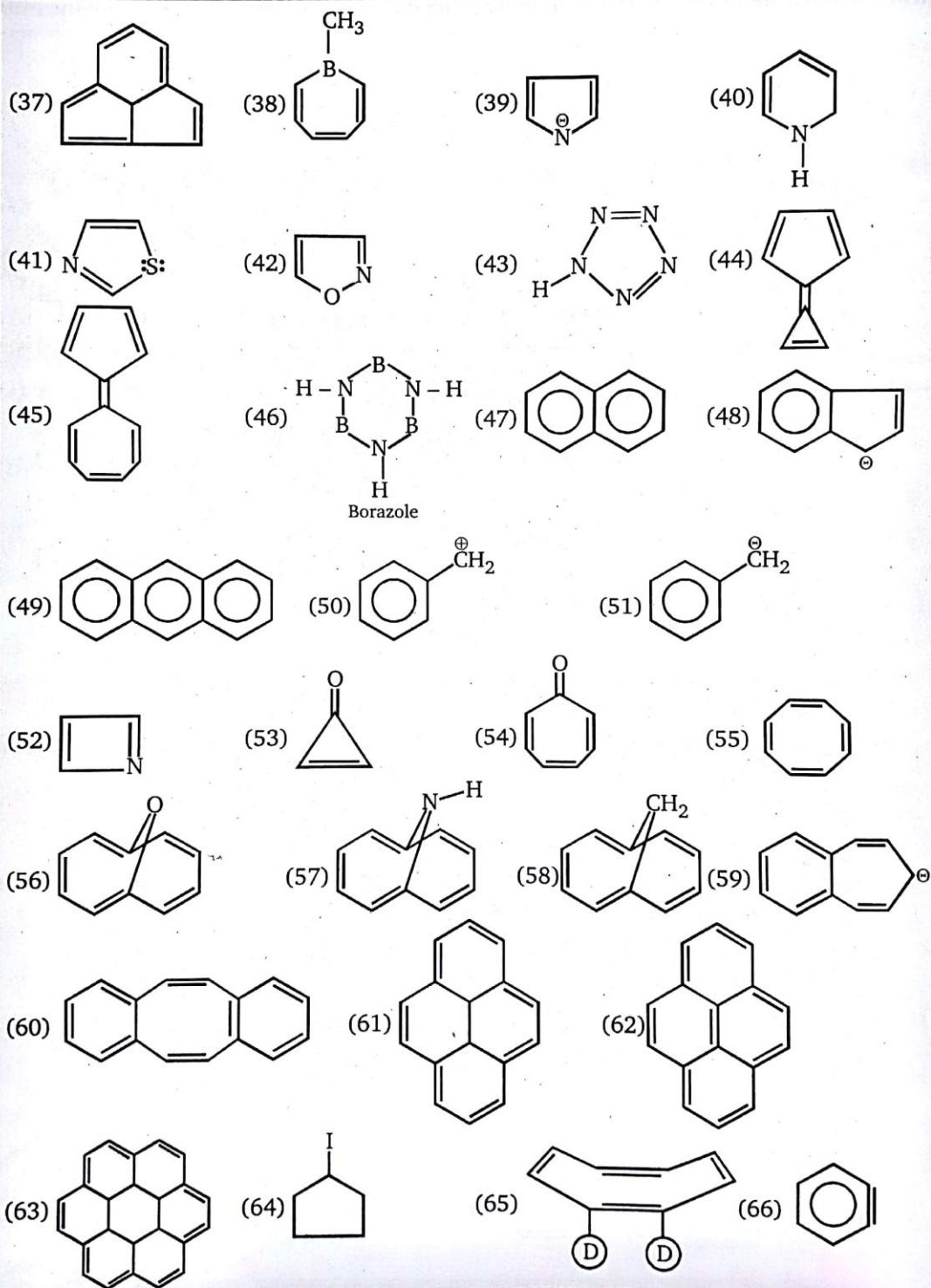
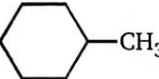
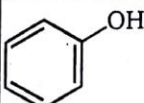
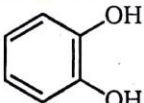
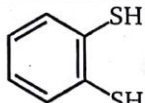
C. Which of the following is the correct product of this reaction ?
(Lone electron pairs are not shown explicitly).

(a) $\oplus O-\overset{\ominus}{B}F_3$; CH_3, CH_3
(b) $\ominus O-\overset{\oplus}{B}F_3$
(c) $\oplus O-\overset{\oplus}{B}F_3$; CH_3
(d) $O^{\ominus}$; $\underset{\oplus}{BF_3}$

36. Rank the following carbocations according to stability (1 = most stable, 5 = least stable).

:ÖCH$_3$

A B C

D E

Put the answer in the boxes.

37. Among the given molecules, identify aromatic, anti-aromatic and non-aromatic molecules.

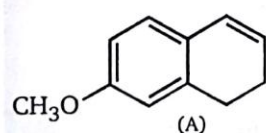
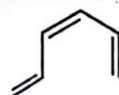
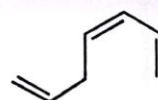
(37)
(38)
CH_3
B
(39)
N
(40)
N
H
(41)
N
S
(42)
N
O
(43)
N=N
H
N
N
N
(44)
(45)
(46)
B
H – N
N – H
B
B
N
H
Borazole
(47)
(48)
(49)
(50)
$\overset{\oplus}{C}H_2$
(51)
$\overset{\ominus}{C}H_2$
(52)
N
(53)
O
(54)
O
(55)
(56)
O
(57)
N—H
(58)
CH_2
(59)
(60)
(61)
(62)
(63)
(64)
I
(65)
D
D
(66)

38. Among the given pairs, which is more reactive towards $AgNO_3$ (or) toward hydrolysis.

	Compound (A)	**Compound (B)**	**Put the Answer here**
1.	O Br	O Br	
2.	Br O	Br	
3.	I	I	
4.	Br	Br	
5.	Cl	Cl	
6.	CH_3-O-CH_2-Cl	$CH_3-CH_2-CH_2-Cl$	
7.	Br	CH_2–Br	
8.	Br	Br	
9.	Br	Br	

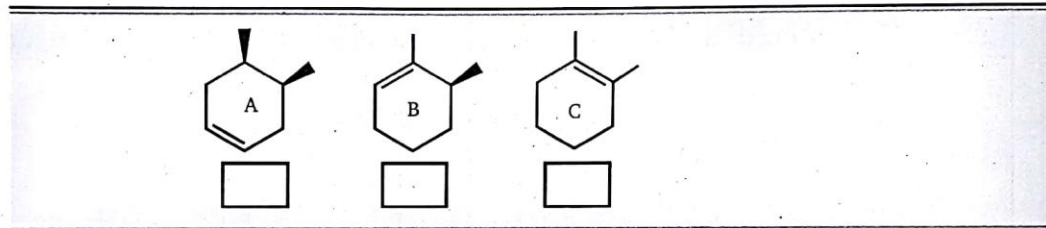
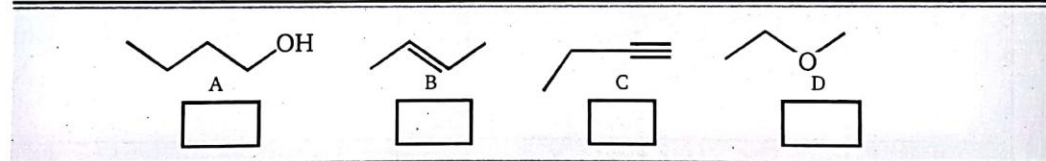
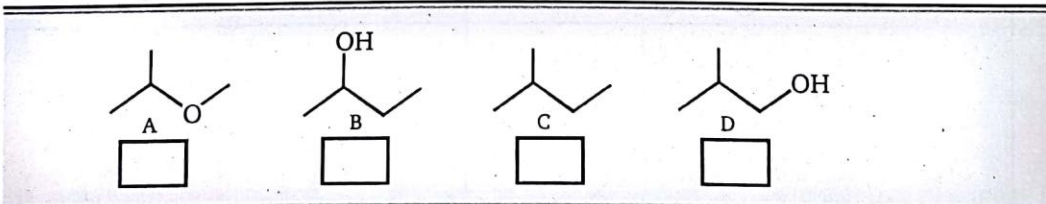
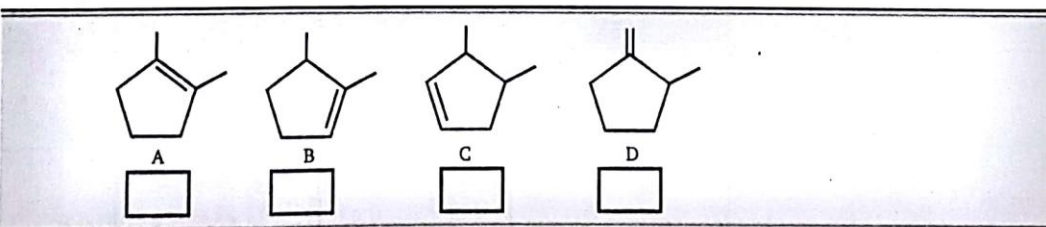
39. Put the answer in boxes given as directed.

S.No.	Property	Molecules	Correct Answer	Name of force responsible for the property
A.	highest boiling point	NCl_3 $ClNH_2$ NH_4Cl NH_3		
B.	highest boiling point	$-CH_3$		
C.	most soluble in water	OH; OH, OH; SH, SH		
D.	highest solubility in benzene	NH; NH		

40. Circle any conjugated portions of these molecules.

CH_3O (A)

$CH_2 = C = CH - CH = CH_2$ (B)

(C)

(D)

41. Arrange in the order as directed -

A. The given alkenes in the order of their stability (1- most stable, 3-least stable).

B. Arrange the following in the order of their acidic strength (1-most acidic, 4-least acidic)

C. Arrange the following molecules in order of expected boiling point. (1=highest bpt ; 4=lowest bpt.)

D. Arrange the following alkenes in order of their stability. (1 = most stable ; 5 = least stable).

42. Match the column. (Matrix)

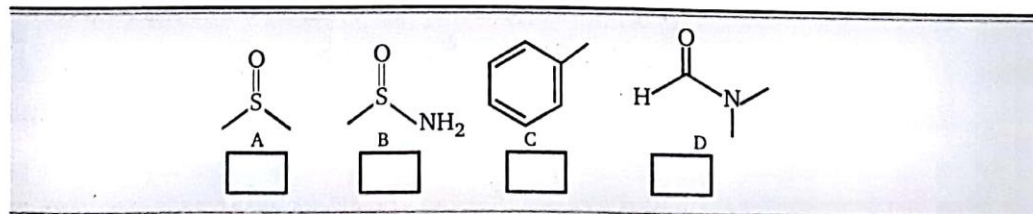
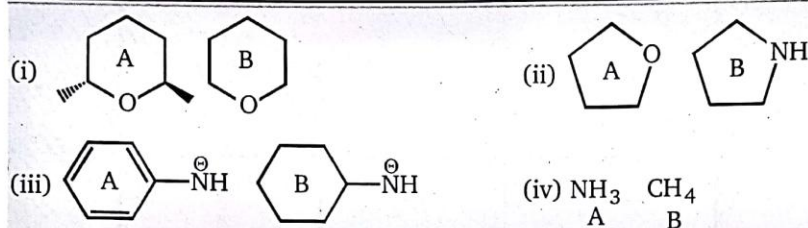
	Column (I) Compounds		Column (II) Number of Benzylic hydrogen
(a)		(p)	2
(b)	CH_2–CH_3, CH_3, CH_3	(q)	3
(c)		(r)	4
(d)		(s)	5

43. Identify (+M) mesomeric & (–M) group of following.

	+M	–M	–I	+I
N				
N, O				

$C_6H_5-C(=O)-NH-CH_3$				
$C_6H_5-C(=O)-CH_3$				
$C_6H_5-NO_2$				
$C_6H_5-OCH_3$				
$C_6H_5-CH=O$				
$C_6H_5-C(=O)-OH$				
$C_6H_5-NH-CH_3$				

44. Identify the following solvents as polar protic (PP), polar aprotic (PA), non-polar protic (NPP) or non-polar aprotic (NPA).

A	B	C	D
$CH_3-S(=O)-CH_3$	$CH_3-S(=O)-NH_2$	$C_6H_5-CH_3$	$H-C(=O)-N(CH_3)_2$
☐	☐	☐	☐

45. Identify the stronger nucleophile in each pair.

46. Encircle the molecule as directed :

(a) Which has higher boiling point : HBr or HCl

(b) Which has a higher boiling point : CH_3-CH_2-OH or $CH_3-CH=O$

(c) Which is more miscible with methanol (CH_3OH) : $CH_3-CH_2-CH_2-CH_2-CH_3$ or $CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$

(d) Which has a higher melting point : CH_4 or $CH_3-CH_2-CH_3$

(e) Which has a higher boiling point : $CH_3-CH_2-CH_2-CH_2-CH_3$ or $CH_3-\underset{CH_3}{\overset{CH_3}{CH_2}}-CH_3$

47. Encircle the molecule as directed :

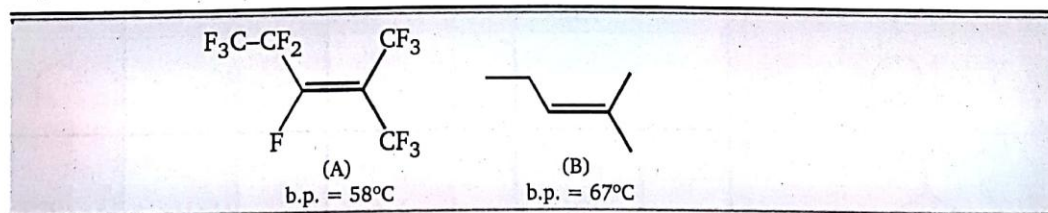
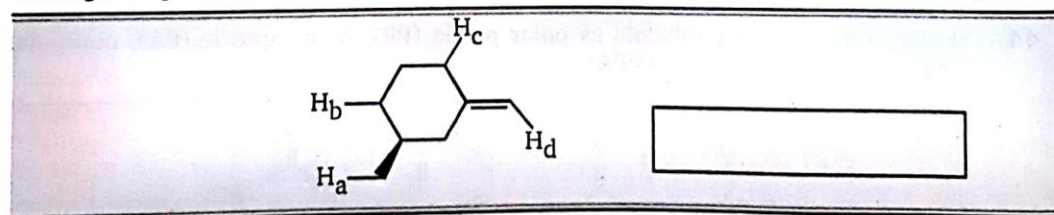
(a) Which is more stable : BH_3 or BF_3

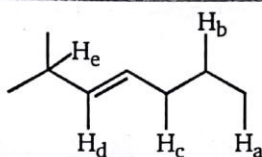
(b) Which is a stronger base : HO^- or H_2O

(c) Which is a stronger base : HO^- or HS^-

(d) Which is a stronger acid : HCl or HI

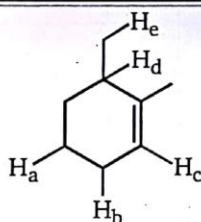
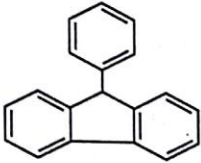
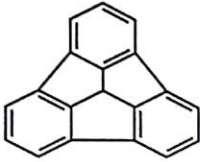
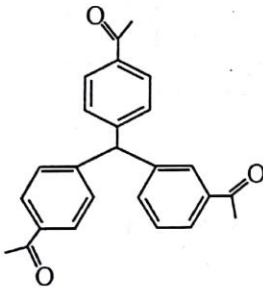
(e) Which is a stronger acid : HOCl or HCl

48. Explain why **A** has lower boiling point than **B** ?

49. Arrange the protons shown in the decreasing order of their approximate bond energies.

50. Consider the H-atoms in the molecule given below and answer the following.

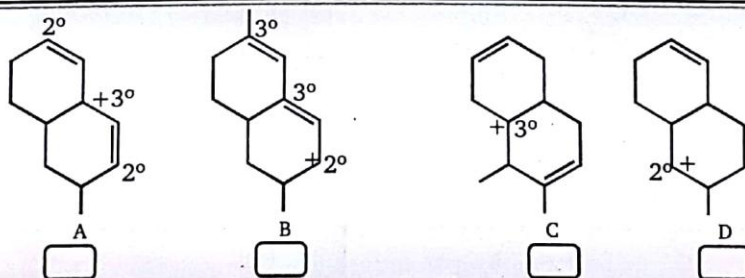
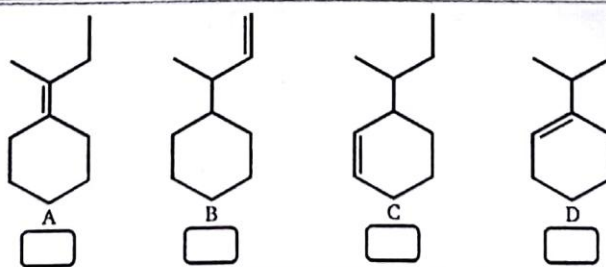
H_b H_e H_d H_c H_a

(A) Identify the type (1°, 2° or 3° alkyl, vinyl, allyl etc.) of these H-atoms.

(B) Arrange them in the decreasing order of their case of abstraction (easiest first)

51. Consider the molecule shown below and answer with respect to $H_a \longrightarrow H_e$

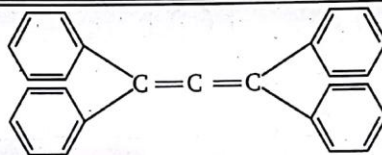
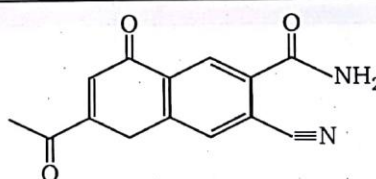
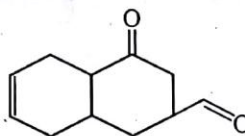
H_e H_d H_a H_c H_b

(A) Identify the type of H-atom (1°, 2°, 3° alkyl, vinyl or allyl)

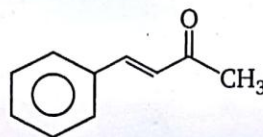
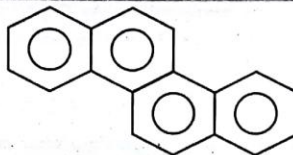
(B) Arrange them in decreasing order of their bond energy.

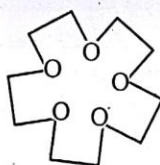
52. Rank the following carbocations in order of stability (1 = most stable).

53. Rank the following alkenes according to energy (1 = lowest energy).

54. Match the column:

	Column (I) (Compounds)		Column (II) (Double bond equivalent value)
(a)		**(p)**	11
(b)		**(q)**	12
(c)	O O O	**(r)**	13
(d)		**(s)**	14
		(t)	15

SUBJECTIVE PROBLEMS

1. How many 2° carbon in the following ?

2. Find out the double bond equivalent (DBE) value of the given following compound:

3. Total number of functional groups present in the given following compound :

4. Total number of α-hydrogen in the given following compound is:

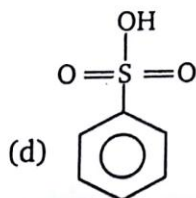
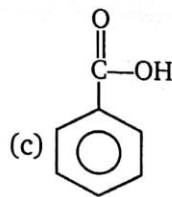
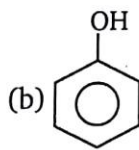
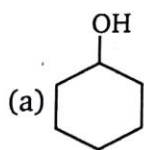
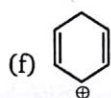
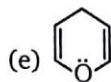
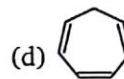
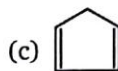
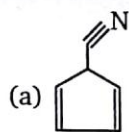
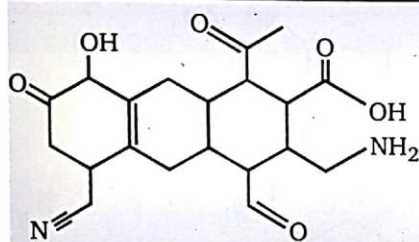
5. How many carbon atom present in the parent chain in the given following compound?

6. Total number of DBE value in :

7. How many isomers of $C_4H_{10}O$ reacts with Na metal to evolve H_2 gas ? (excluding stereoisomer)

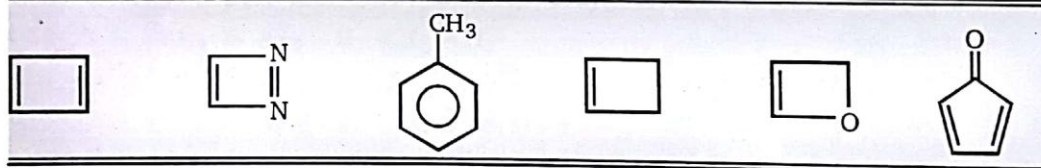
8.

[x]-crown-[y]-ether.

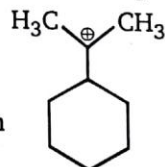
value of $\frac{x+y}{3}$ = ?

9. Which of the given following compound will react with $NaHCO_3$ or soluble in $NaHCO_3$?

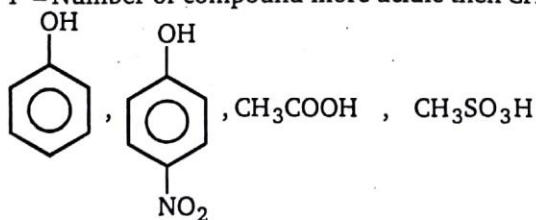
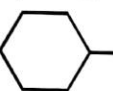
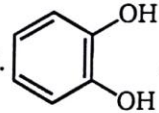
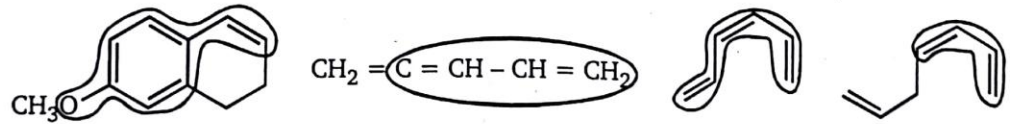
(a) (b) (c)

(d) (e) $CH_3-C\equiv CH$

10. How many compound are stable after deprotonation ?

11.

Sum of types of functional group and DBE value for given compound is X so the value of $X - 10$ is

12. P = Number of anti-aromatic compound, so the value of x is :

Q = Total number of resonating structures of carbonate ion $[CO_3^{2-}]$

R = Number of α-hydrogen in given carbocation

S = Total number of geometrical isomers of $CH_3 - CH = CH - CH = CH_2$

T = Number of compound more acidic then CH_3CH_2OH

, , CH_3COOH , CH_3SO_3H

Sum of $(P + Q + R + S + T) - 15$ is :

13. x = number of $(+M)$ group attached with phenyl ring, so the value of x is.

(a) C_6H_5–OH

(b) C_6H_5–NH_2

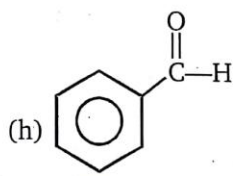
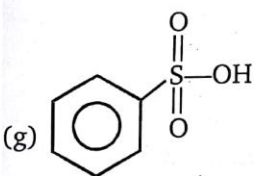
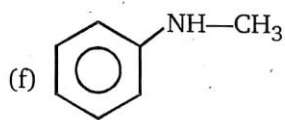
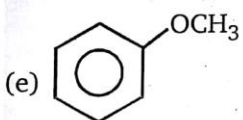
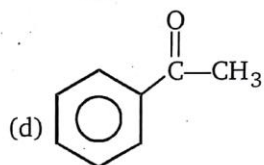
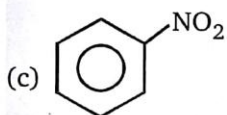
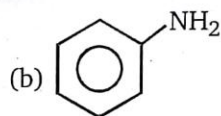
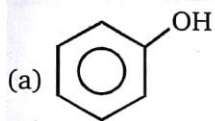
(c) C_6H_5–NO_2

(d) C_6H_5–C(=O)–CH_3

(e) C_6H_5–OCH_3

(f) C_6H_5–NH–CH_3

(g) C_6H_5–S(=O)(=O)–OH

(h) C_6H_5–C(=O)–H

ANSWERS — LEVEL 2

1. a – 4; b – 3; c – 2; d – 1

2. a – 3; b – 2; c – 1

3. A – b; B – e; C – a; D – b

4. A – a, c, f, g, k, l; B – b, d, h, j; C – e, i

5. A –d; B – a

6. C < B < A

7. a – 2, 1, 4, 3; b – 1, 2, 3, 4 ; c – 3, 4, 1, 2; d – 3, 2, 4, 1

8. a – iv > ii > i > iii; b – iii > iv > i > ii

9. a – 4, 2, 3, 1; b – 3, 1, 4, 2; c – 2, 1, 3, 4; d – 2, 3, 4, 1

10. A (i) – d > b > c > a; (ii) – c > a > b > d
B (i) – c > d > b > a; (ii) – b > d > c > a

11. (a) 3 2 1 4; (b) 2 1 4 3; (c) 3 1 2 4; (d) 3 4 1 2

12. A – c < a < b; B – b < a < c < d; C – d < b < c < a

13. A – c < a < b; B – a < b < c; C – c < b < a; D – d < c < a <b; E – c < a < b; F – a > b > c

14. A – $H_c < H_a < H_b$; B – $H_d < H_c < H_b < H_a$

15. A – 1, 3, 4, 6, 7, 8, 9; B – 2, 5; C – 6; D – 3, 4, 6, 7, 9; E – 6, 8, 9; F – 6; G – 7; H – 9; I – 4,7

16. A – b; B – a; C – d; D – b; E – a; F – d; G – d; H – a

17.

	(i)	(ii)	(iii)	(iv)	(v)
A	6	4	0	10	2
B	0	7	2	9	6
C	5	1	0	5	1
D	1	3	1	3	4
E	2	3	0	2	2
F	10	0	0	10	0

18. a – q; b – p, r; c – p, s; d – q

19. a – p; b– r; c – s; d – q

20. A – c; B – d

21. A – b; B – b; C – a

22. a – p, s; b – q, r; c – q, s; d – p, s

23. a – p, r, s; b – q, r; c – q, r; d – p, r, s

24. A – b; B – c; C – a; D – c; E – a; F – b; G – d

25. A – d; B – a; C – d; D – c

26. A – c; B – b; C – b; D – b; E – b; F – a; G – b; H – c; I – b

27. i. – *sp*; ii – *sp*; iii –sp^2 ; iv – sp^2; v – sp^3; vi – sp^3

28. a – forward b – backward

29. a – p. q, s; b – p, q, r, s; c – p, q, r, s; d – p, q, r, s

30. a – s; b – r; c – q; d – p

31. a – r; b – q; c – s; d – p

32. b

33. 65

34. a – q; b – r; c – s; d – p

35. A – d; B – a; C – a

36. A – 3; B – 1; C – 5; D – 2; E – 4

37. Aromatic— 3, 4, 5, 9, 12, 13, 15, 16, 17, 19, 22, 24, 25, 26 ,27, 28, 29, 31, 32, 33, 34, 35, 37, 38, 39, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51 , 53, 54, 56, 57, 58, 61, 62, 63, 66

Non-aromatic— 1, 6, 7, 8, 18, 20, 23, 30, 40, 55, 64, 65

Anti-aromatic— 2, 10, 11, 14, 21, 36, 52, 59, 60

38. 1 – B; 2 – A; 3 – B; 4 – A; 5 – A; 6 – A; 7 – B; 8 – B; 9 – A; 10 – A

39. A. NH_4Cl, cation-anion interactoin

40.

$CH_2 = C = CH - CH = CH_2$

41. **A.** A – 3, B – 2, C – 1,

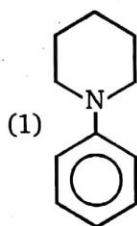
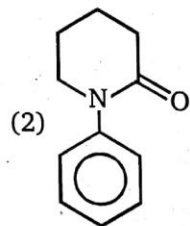
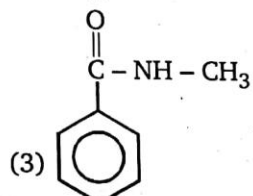
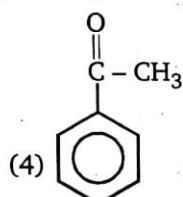
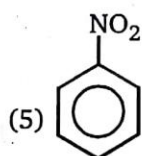
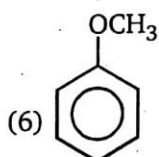
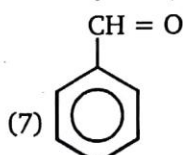
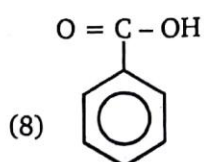
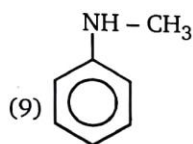
B. A – 1, B – 3, C – 2, D – 4

C. A – 3, B – 1, C – 4, D – 2

D. A – 1, B – 2, C – 3, D – 4

42. a – s; b – r; c – q; d – p

43.

	+M	–M	–I	+I
(1) N	✓	×	✓	×
(2) N, O	✓	×	✓	×
(3) $\overset{O}{\overset{\|\|}{C}}-NH-CH_3$	×	✓	✓	×
(4) $\overset{O}{\overset{\|\|}{C}}-CH_3$	×	✓	✓	×
(5) NO_2	×	✓	✓	×
(6) OCH_3	✓	×	✓	×
(7) $CH=O$	×	✓	✓	×
(8) $O=C-OH$	×	✓	✓	×

44. A – PA; B – PP; C – NPA; D – PA

45. (i) B, (ii) B, (iii) B, (iv) A

46. (a) HBr; (b) CH_3-CH_2-OH; (c) $CH_3-CH_2-CH_2-CH_2-CH_3$; (d) $CH_3-CH_2-CH_3$; (e) $CH_3-CH_2-CH_2-CH_2-CH_3$

47. (a) BF_3; (b) HO^-; (c) HO^-; (d) HI; (e) $HOCl$

48. In A, highly electronegative F-atoms are present at the periphery. In liquid term these F-atoms will repel each other due to partial negative charge and thus A will have lower b.pt.

49. $H_d > H_a > H_b > H_c$

50. A– H_a =1° alkyl; H_b = 2° alkyl; H_c =2° allyl; H_d = vinyl; H_e = 3° allyl

B– Easiest to abstract: $H_e > H_c > H_b > H_a > H_d$ Hardest to abstract

51. A– H_a = 2° alkyl; H_b = 2° allyl; H_c = vinyl; H_d = 3° allyl; H_e = 1° alkyl

B– $H_c > H_e > H_a > H_b > H_d$

52. A–2; B–1; C–3; D–4

53. A–1; B–4; C–3; D–2

54. a-r; b-t; c-t; d-s

Subjective Problems

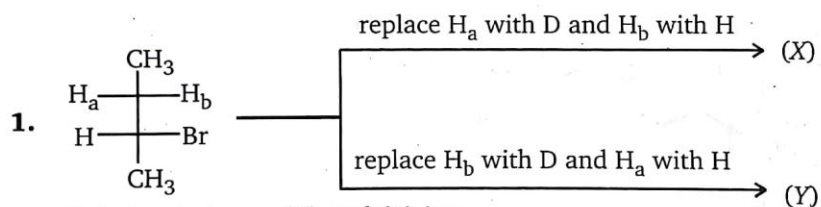
1. 21 **2.** 11 **3.** 3 **4.** 6 **5.** 4 **6.** 13 **7.** 4 **8.** 7

9. 2 (c, d) **10.** 3 (a, c, f) **11.** 7

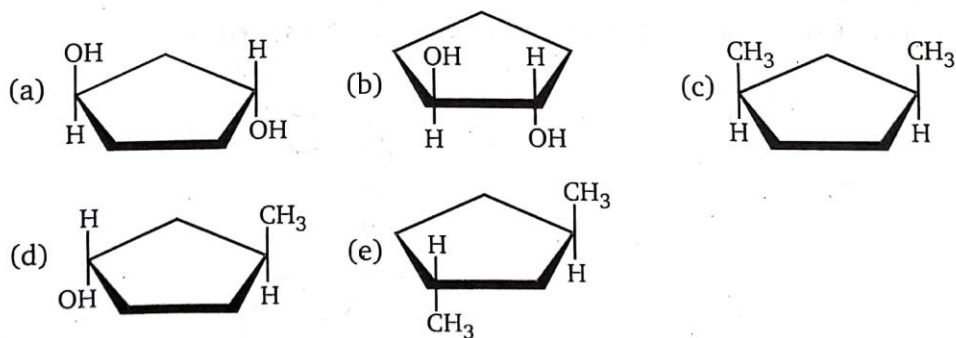
12. $P = 3, Q = 3, R = 7, S = 2, T = 4 = 19 - 15 = \mathbf{4}$ **13.** 4

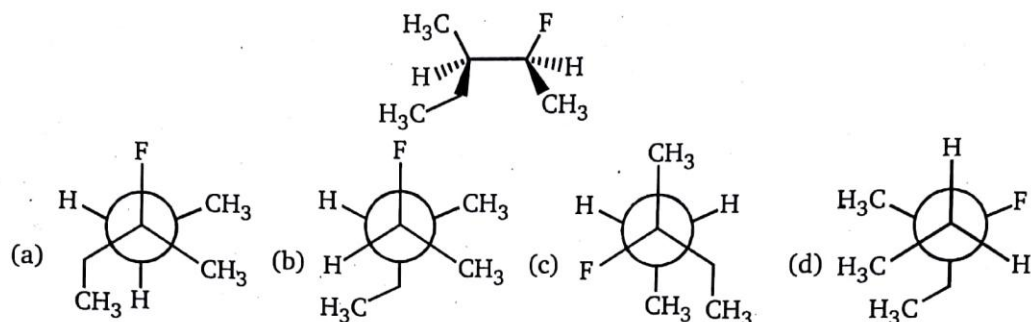
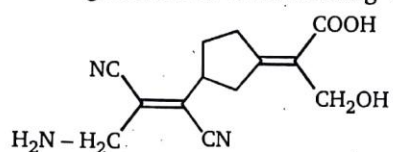
2 ISOMERISM (Structural & Stereoisomerism)

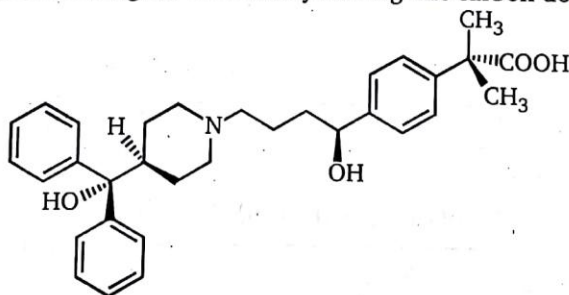
LEVEL-1

1.

Relation between (*X*) and (*Y*) is :

(a) enantiomers
(b) diastereomers
(c) *E* and *Z* isomer
(d) constitutional isomer

2. Which of the following cyclopentane derivative is optically **inactive** ?

3. Which is the most stable conformer along the 2, 3 C – C bond axis of the compound ?

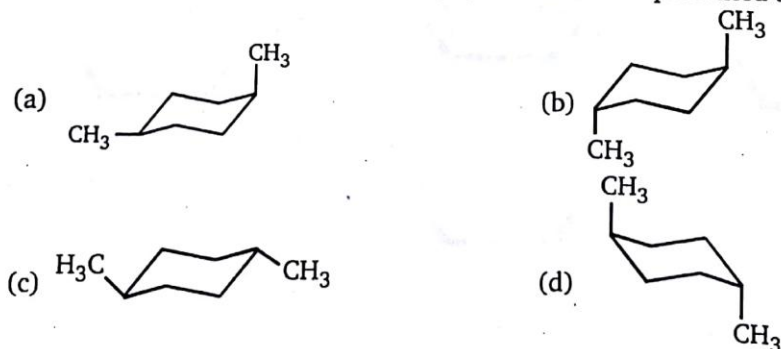
(a) (b) (c) (d)

4. Assign double bond configurations to the following :

(a) E (b) Z (c) E, E (d) Z, Z

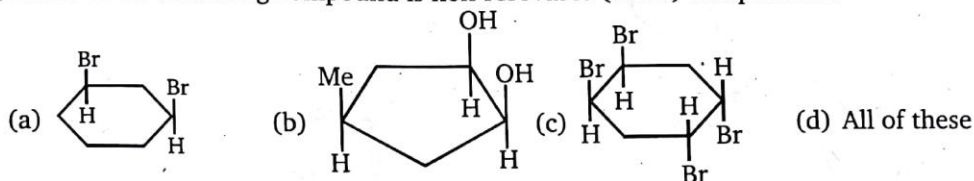
5. Allegra, a common prescription drug with the structure shown below, is given for the treatment of seasonal allergies. How many stereogenic carbon does Allegra possess ?

(a) 1 (b) 2 (c) 3 (d) 4

6. How many meso isomers of $C_4H_8Cl_2$ will be ?

(a) 0 (b) 1 (c) 2 (d) 3

7. The stable form of *trans*-1, 4-dimethylcyclohexane is represented as:

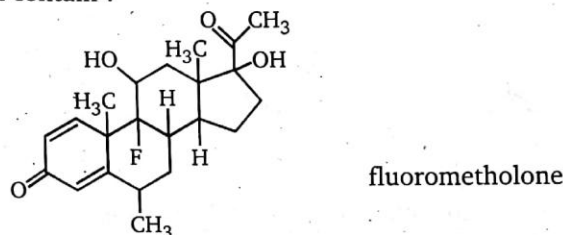
(a) (b) (c) (d)

8. Which of the following compound is non-resovable (meso) compounds ?

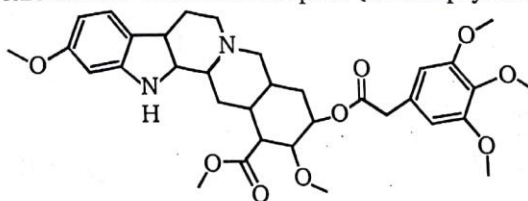
(d) All of these

9. $HO-\underset{(2)}{CH_2}-\underset{(3)}{CH_2}-F$

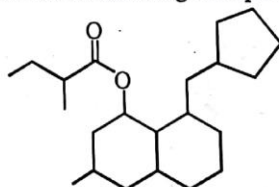
Which conformer of above compound is most stable across C_2-C_3?

(a) staggered (b) eclipsed (partially)
(c) gauche (d) fully eclipsed

10. The following molecule is fluorometholone, a steroidal anti-inflammatory agent. How many stereogenic centers does it contain ?

fluorometholone

(a) 5 (b) 6 (c) 7 (d) 8

11. How many chiral carbons are there in Reserpine (an antipsychotic drug) ?

(a) 9 (b) 8 (c) 7 (d) 6

12. How many chiral centers are in the following compound ?

(a) 4 (b) 5 (c) 6 (d) 7

13. Among the following, the optically inactive compound is:

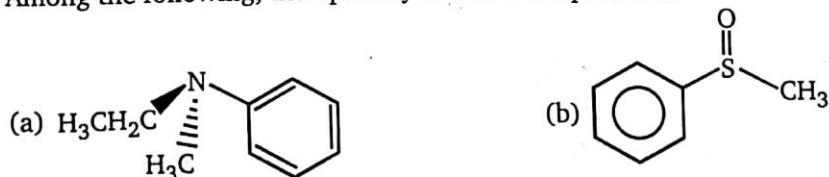
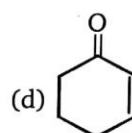
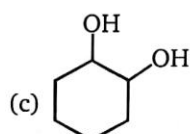
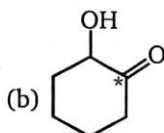
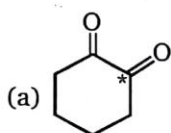
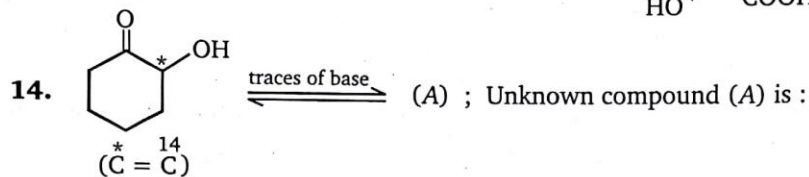
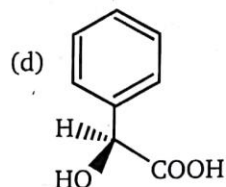
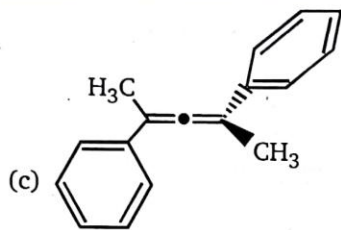
(b) $C_6H_5-S(=O)-CH_3$

(c) H_3C ... CH_3

(d) H, HO, COOH

14. O, OH, * $\xrightarrow{\text{traces of base}}$ (A) ; Unknown compound (A) is :

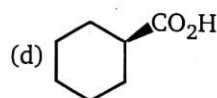
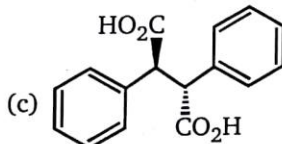
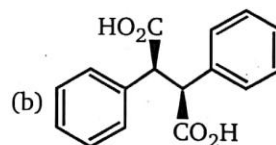
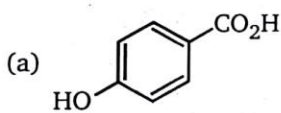
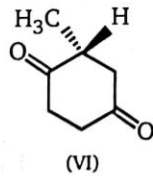
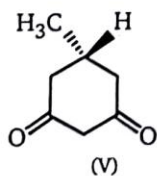
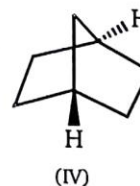
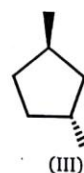
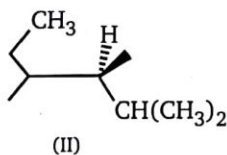
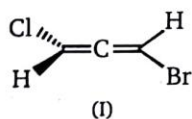
$(\overset{*}{C} = \overset{14}{C})$

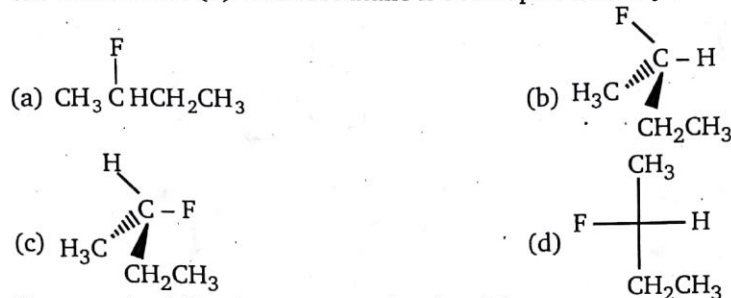
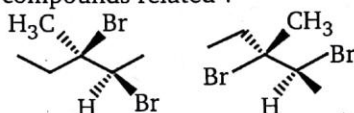
(a) (b) OH (c) OH, OH (d) O

15. Which of the following compounds might be useful to the chemist trying to increase the optical purity of the (d) sample ?

(a) CO_2H, HO

(b) HO_2C, CO_2H

(c) HO_2C, CO_2H

(d) CO_2H

16. Which of the following molecules is (are) chiral ?

(a) I and II (b) III and IV (c) II, IV and VI (d) I, II, III and VI

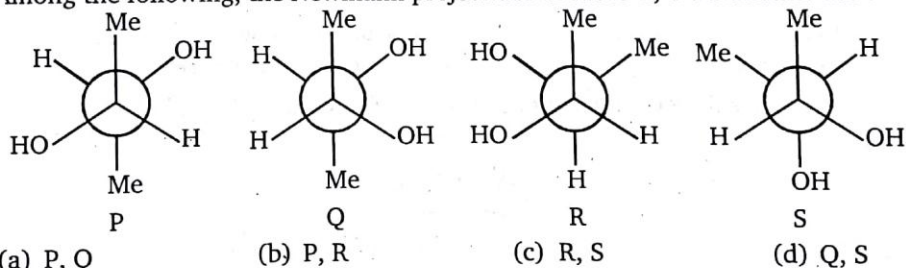
17. The structure of (S)-2-fluorobutane is best represented by :

18. How are the following compounds related ?

(a) Diastereomers (b) Enantiomers
(c) Meso compounds (d) Identical

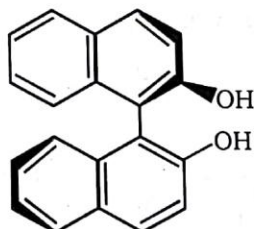
19. Which one of the following is chiral ?

(a) 1, 1-Dibromo-1-chloropropane (b) 1, 3-Dibromo-1-chloropropane
(c) 1, 1-Dibromo-3-chloropropane (d) 1, 3-Dibromo-2-chloropropane

20. Among the following, the Newmann projections of meso-2, 3-butanediol are :

P: Me (front top), H, OH, HO, H, Me (bottom)
Q: Me (top), H, OH, H, OH, Me (bottom)
R: Me (top), HO, Me, HO, H, H (bottom)
S: Me (top), Me, H, H, OH, OH (bottom)

(a) P, Q (b) P, R (c) R, S (d) Q, S

21. The binaphthol (**Bnp**) is:

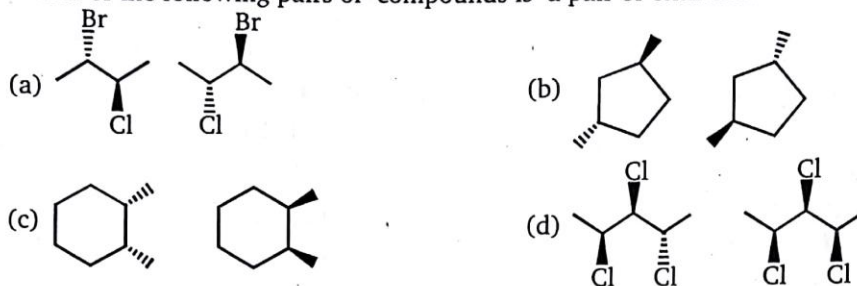
OH
OH

(a) an optically active compound having chiral centre
(b) an optically inactive compound
(c) a meso compound
(d) an optically active compound without having chiral centre

22. Which of the following pairs of compounds is a pair of enantiomers ?

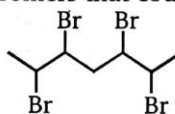
(a)

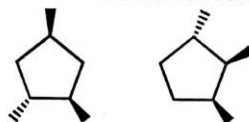
(b)

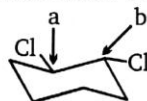
(c)

(d)

23. The maximum number of stereoisomers that could exist for the compound below ?

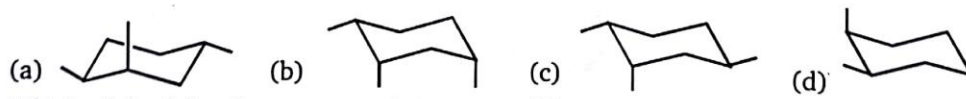
Br Br

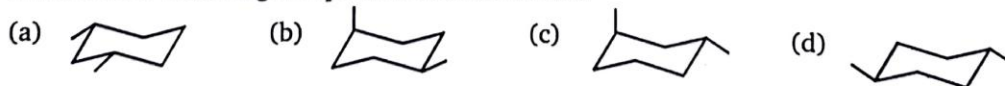
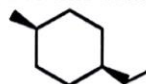
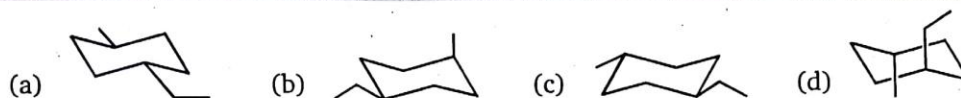
Br Br

(a) 6 (b) 8 (c) 10 (d) 16

24. The following pair of compounds is best described as :

(a) identical (b) diastereomers
(c) enantiomers (d) none of the above

25. Determine the absolute configurations of the labeled carbons (a and b):

(a) $a = \text{R}\,;\, b = \text{R}$ (b) $a = \text{R}\,;\, b = \text{S}$
(c) $a = \text{S}\,;\, b = \text{R}$ (d) $a = \text{S}\,;\, b = \text{S}$

26. Which of the structures (a – d) will be produced if a "ring flip" occurs in the following compound in chair form ?

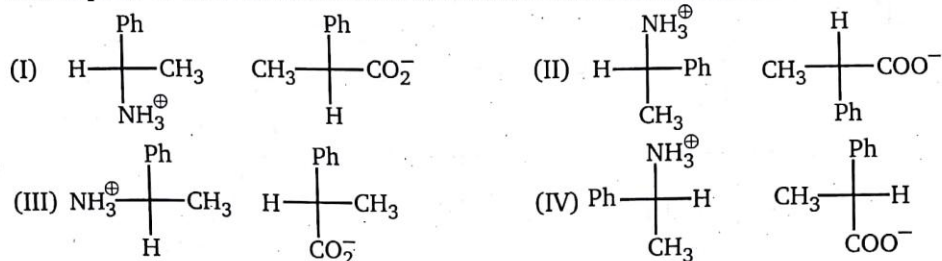
(a) (b) (c) (d)

27. Which of the following compounds is most stable ?

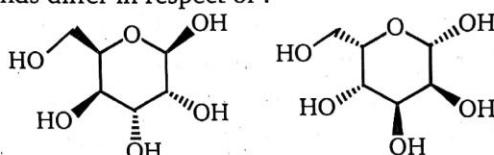
(a) (b) (c) (d)

28. Which is the most stable chair form of this compound ?

29. Which pairs of the salts would have identical solubilities in methanol ?

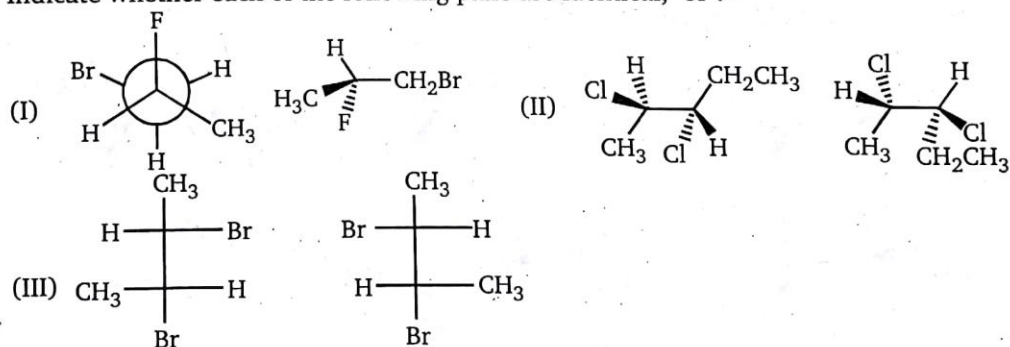
(I) Ph / H—C—CH_3 / $NH_3^{\oplus}$; Ph / CH_3—C—CO_2^- / H

(II) $NH_3^{\oplus}$ / H—C—Ph / CH_3 ; H / CH_3—C—COO^- / Ph

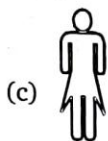
(III) Ph / $NH_3^{\oplus}$—C—CH_3 / H ; Ph / H—C—CH_3 / CO_2^-

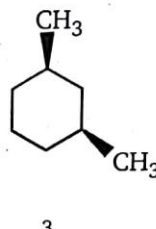
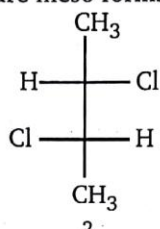
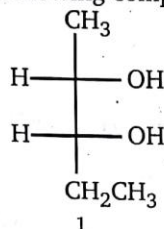
(IV) $NH_3^{\oplus}$ / Ph—C—H / CH_3 ; Ph / CH_3—C—H / COO^-

(a) I & IV (b) I & III (c) I & II (d) II & IV

30. The following compounds differ in respect of :

(a) their chemical and physical properties
(b) nothing
(c) the direction in which they rotate plane of polarized light
(d) their interactions with molecules

31. Indicate whether each of the following pairs are identical, or ?

	I	II	III
(a)	enantiomers	diastereomers	enantiomers
(b)	identical	enantiomers	enantiomers
(c)	enantiomers	diastereomers	identical
(d)	enantiomers	identical	identical

32. Which of the following is achiral ?

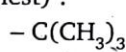
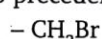
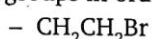
(c)

(d) a molecule of 3-methylheptane

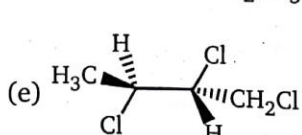
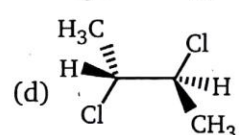
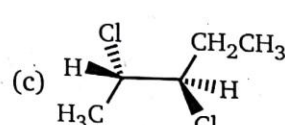
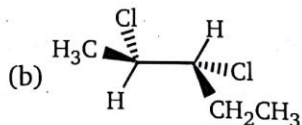
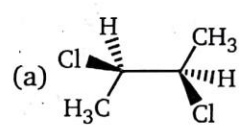
33. Which of the following compounds are meso forms ?

(a) 1 only
(b) 3 only
(c) 1 and 2
(d) 2 and 3

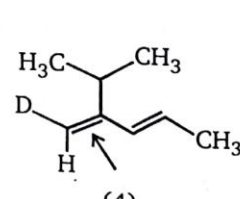
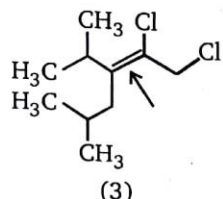
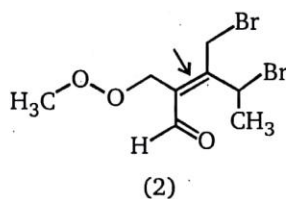
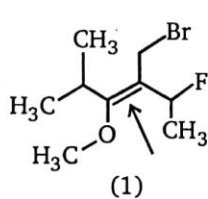
34. The separation of a racemic mixture into pure enantiomers is termed as :

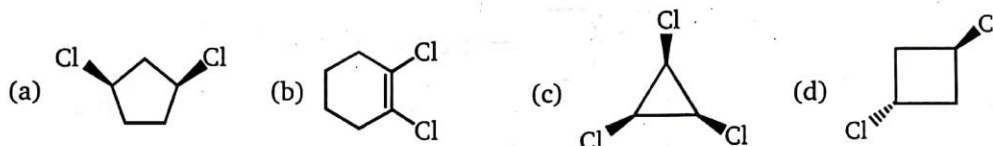
(a) Racemization (b) Isomerization (c) Resolution (d) Equilibration

35. Rank of the following groups in order of R, S precedence (IV is highest) :

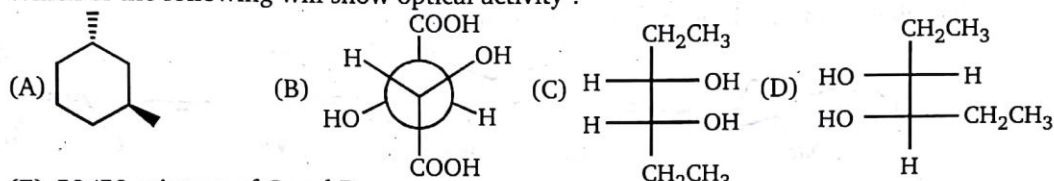
$-CH(CH_3)_2$ 1 $-CH_2CH_2Br$ 2 $-CH_2Br$ 3 $-C(CH_3)_3$ 4

	I	II	III	IV		I	II	III	IV
(a)	3	2	4	1	(b)	1	4	2	3
(c)	3	4	1	2	(d)	3	4	2	1

36. Which of the following is a meso compound ?

37. Among the following structures, select E isomers (arrows indicate the bonds to be considered) ?

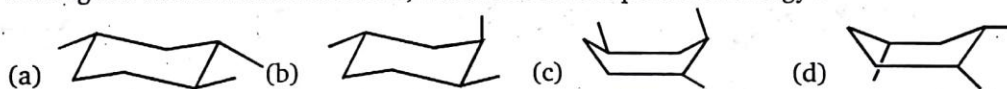
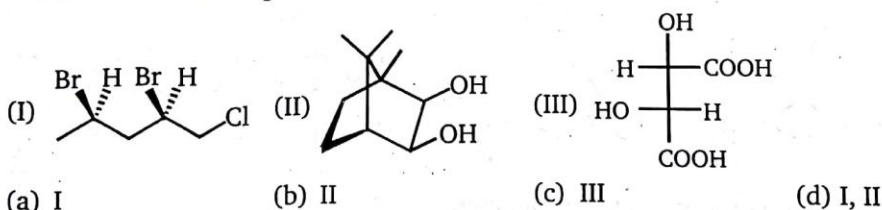
(1) (2) (3) (4)

(a) 1 and 2 (b) 1 and 3 (c) 1 and 4 (d) 2 and 3

38. Which of the following compounds has a zero dipole moment ?

39. On Pluto, where everything is frozen, astronauts discovered two forms of butane gauche and anti. Assuming that there are no rotations around single bonds, which statement about the two forms is correct ?

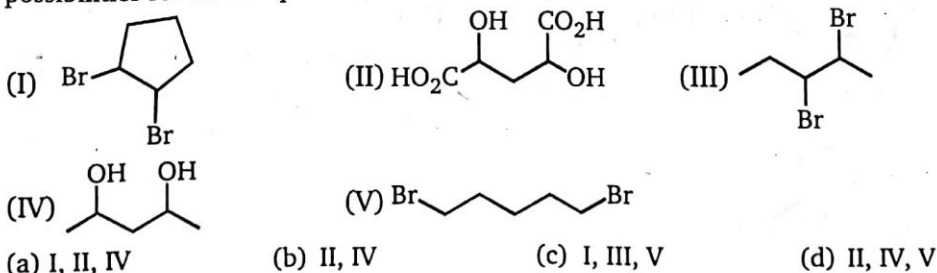
(a) They are enantiomers
(b) They are diastereoisomers
(c) They are meso compounds
(d) The gauche form has two stereogenic centers, and the anti has only one

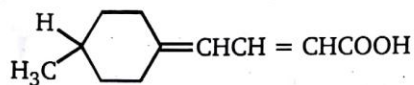
40. Which of the following will show optical activity ?

(E) 50/50 mixture of C and D

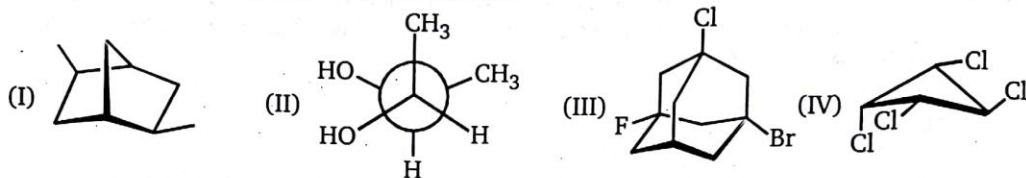
(a) A, D and E (b) A and E only (c) B, C and D (d) All except C

41. Among the structure shown below, which has lowest potential energy ?

42. Which of the following molecules is/are chiral ?

(a) I (b) II (c) III (d) I, II

43. A compound was synthesized by a student, but its structure was not identified. However, his wonderfully helpful instructor told him that it was a meso compound with 5 carbons and 2 stereogenic centers. Which of the following structures should the student consider as possibilities for his compound ?

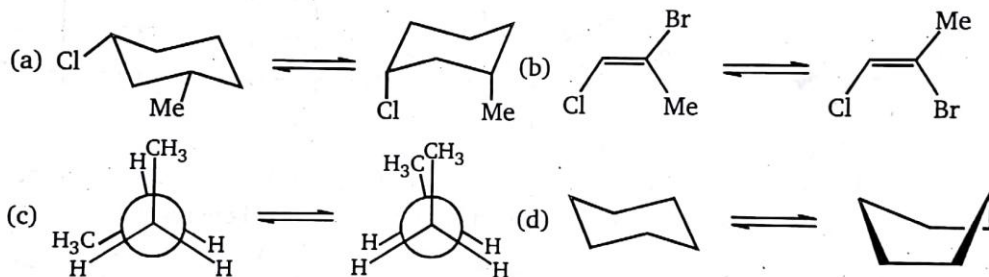
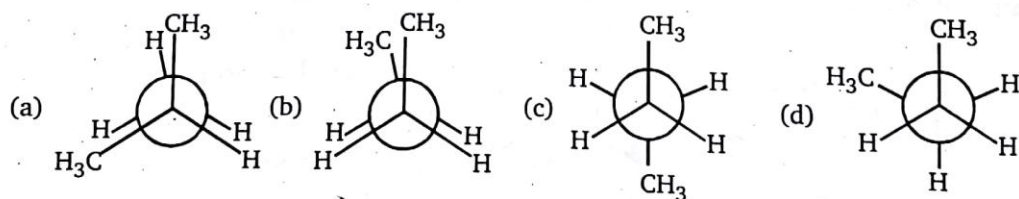
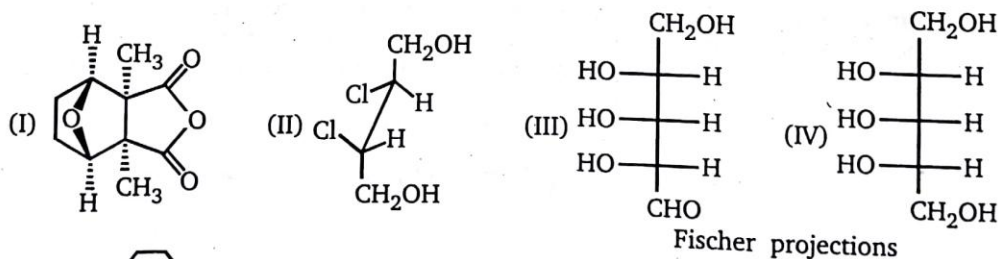
(a) I, II, IV (b) II, IV (c) I, III, V (d) II, IV, V

44. How many isomers are possible for the following molecule ?

H, H_3C (ring) $=CHCH = CHCOOH$

(a) 1 (b) 2 (c) 3 (d) 4

45. Which of the following molecules are chiral ?

(a) I, II, III and IV (b) II, III and IV (c) II and IV (d) I and II

46. Which equilibrium is not rapid at room temperature ?

(a) Cl, Me ⇌ Cl, Me (b) Cl, Br, Me ⇌ Cl, Me, Br

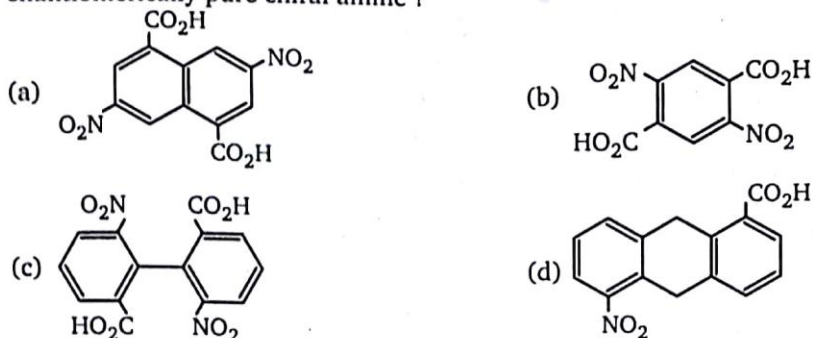
(c) H, CH_3, H_3C, H, H, H ⇌ H_3C, CH_3, H, H, H, H (d)

47. Which is the lowest energy conformation of butane ?

48. Which of the structures given below are chiral ?

(a) I, II, III (b) II, III, V (c) II, III (d) I, II

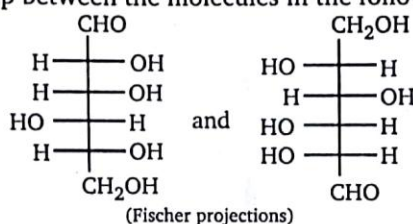
49. Which of the following carboxylic acids could be resolved by reaction with an enantiomerically pure chiral amine ?

(a)

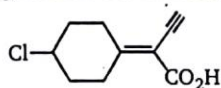
(b) O_2N, CO_2H, HO_2C, NO_2

(c) O_2N, CO_2H, HO_2C, NO_2

(d) CO_2H, NO_2

50. What is the relationship between the molecules in the following pairs ?

(Fischer projections)

(a) enantiomers (b) diastereomers (c) identical (d) structural isomers

51. What are the correct designations for the structure below ?

Cl, CO_2H

(a) E, E
(b) Z, E
(c) E, Z
(d) No geometrical isomers are possible

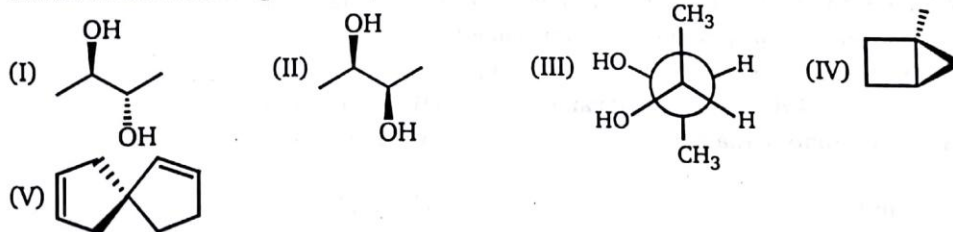
52. Which of the following molecules are chiral ?

(I)

(II) OH, OH

(III) HO, CH_3, H, HO, H, CH_3

(IV)

(V)

(a) I and III (b) I and V (c) II and III (d) II, III, IV

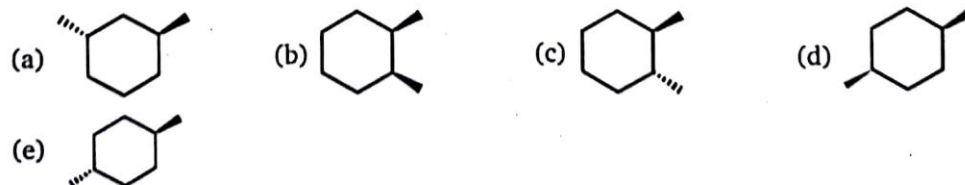
53. Which one of the following isomeric structures has the lowest energy ?

(a)

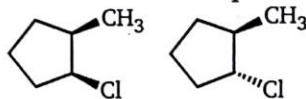
(b)

(c)

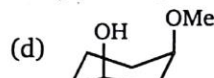
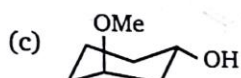
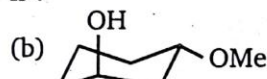
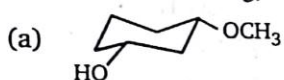
(d)

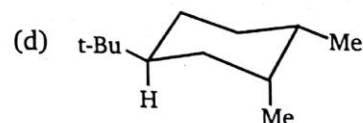
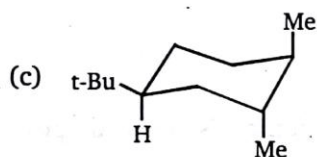
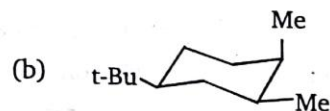
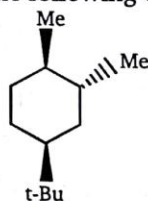
(e)

54. The following compounds are identical with respect to :

CH_3 CH_3

Cl Cl

(a) molecular composition
(b) boiling point
(c) melting point
(d) IUPAC name

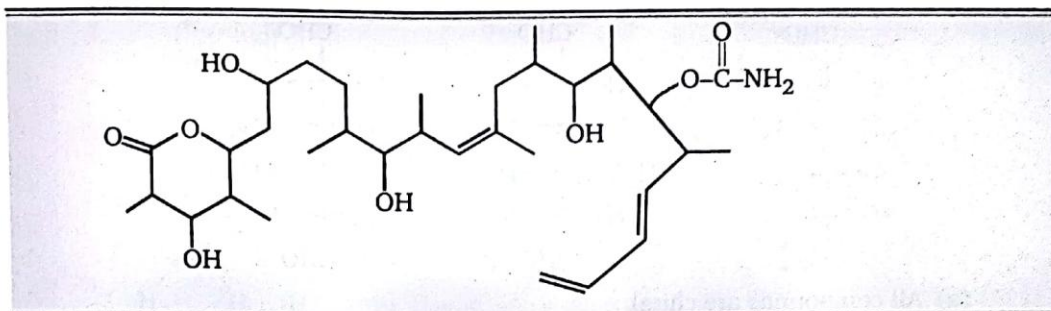
55. Among the following, the most stable isomer is :

(a) HO, OCH_3
(b) OH, OMe
(c) OMe, OH
(d) OH, OMe

56. The most stable conformation of the following compound is :

(a) t-Bu, Me, Me
(b) t-Bu, Me, Me
(c) t-Bu, H, Me, Me
(d) t-Bu, H, Me, Me

57. Which of the following molecules have non-zero dipole moments ?

(I) gauche conformation of 1, 2-dibromoethane
(II) anti conformation of 1, 2-dibromoethane
(III) *trans*-1, 4-dibromocyclohexane
(IV) *cis*-1, 4-dibromocyclohexane
(V) tetrabromomethane
(VI) 1, 1-dibromocyclohexane

(a) I and II
(b) I and IV
(c) II and V
(d) I, IV and VI

58. What is the maximum number of stereoisomers possible for discodermolide ?

(a) 2^{14} (b) 2^{15} (c) 2^{16} (d) 2^{17}

59. An aqueous solution containing compounds *A* and *B* shows optical activity. *A* and *B* are stereoisomers. Which of the following possibilities cannot be correct ?

(a) *A* has two chiral centers, but *B* does not have any because it has a symmetry plane

(b) *A* and *B* are enantiomers

(c) *A* and *B* are diastereomers

(d) *A* and *B* are not present in equal amounts

60. Which of the following structures represents the lowest-energy form of (1S, 2S, 4R)-trimethyl -cyclohexane ?

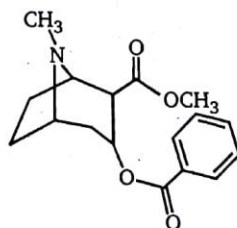
61. Which one of the following is a diastereomer of (R)-4-bromo-cis-2-hexene ?

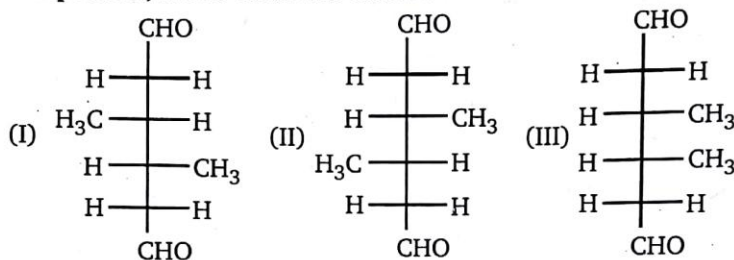
(a) (S)-4-bromo-*cis*-2-hexene

(b) (S)-5-bromo-*trans*-2-hexene

(c) (R)-4-bromo-*trans*-2-hexene

(d) (R)-5-bromo-*trans*-2-hexene

62. The structural formula of cocaine is shown below. How many stereogenic carbon atoms are there in this molecule ?

(a) 1 (b) 2 (c) 3 (d) 4

63. Which of the following statements best describes the stereochemical relationships of compound I, II and III shown below ?

(a) All compounds are chiral

(b) None of the compounds is chiral

(c) I and II are meso compounds

(d) I and II are diastereomers, and III is a meso compound

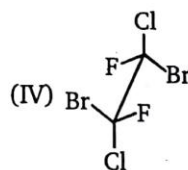
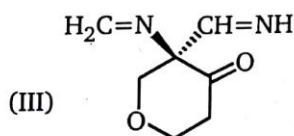
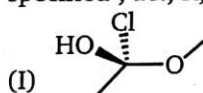
(e) I and II are chiral

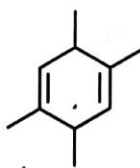
64. What is the absolute configuration of the following molecules ? (NS = the molecule has no center) Note : For the purpose of this question only, the order of stereocenters is not specified ; *i.e.*, R, S = S, R.

(I) HO, Cl, O

(II)

(III) $H_2C{=}N$, $CH{=}NH$, O, O

(IV) Cl, F, Br, Br, F, Cl

	I	II	III	IV
(a)	R	R, S	R	NS
(b)	R	R, R	S	R, R
(c)	R	R, S	NS	NS
(d)	R	R, S	R	R, S

65. The number of all the possible stereoisomers formed by the given compound is :

(a) 2

(b) 3

(c) 32

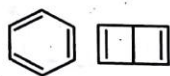
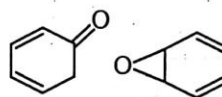
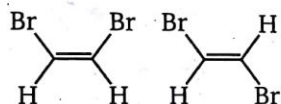
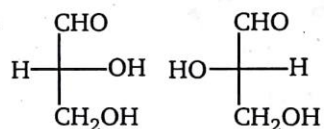
(d) 64

66. The relationship among the following pairs of isomers is:

(I) (II)

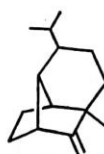
Br, Br / H, H (cis) Br, H / H, Br (trans)

(III)

CHO; H–C–OH; CH_2OH CHO; HO–C–H; CH_2OH

(IV)

I	A: Constitutional
II	B: Configurational
III	C: Conformational
IV	D: Optical

(a) I – A, II – B, III – B, IV – D
(b) I – A, II – A, III – B, IV – D
(c) I – B, II – A, III – B, IV – D
(d) I – B, II – B, III – A, IV – B

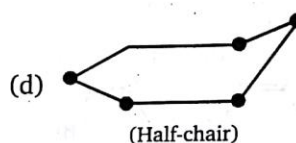
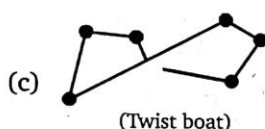
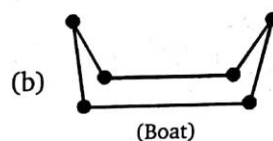
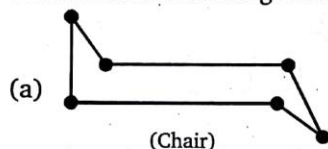
67. The structural formula of sativene is shown below. How many stereogenic centers are there in this molecule ?

(a) 2
(b) 3
(c) 4
(d) 5

68. Which of the following is the least stable conformer of cyclohexane ?

(a)
(Chair)

(b)
(Boat)

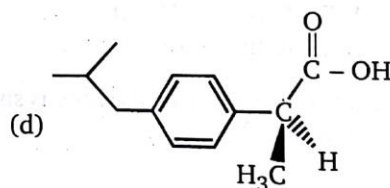
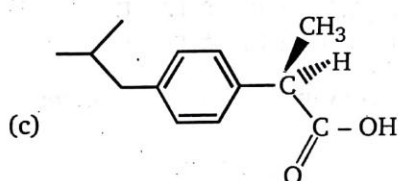
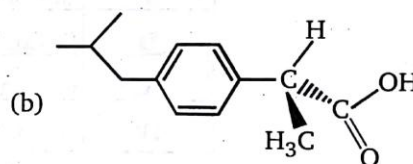
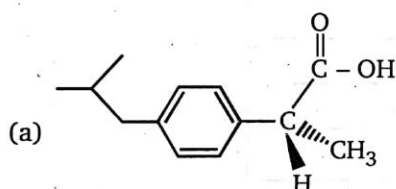
(c)
(Twist boat)

(d)
(Half-chair)

69. The S- enantiomer of ibuprofen is responsible for its pain-relieving properties. Which one of the following structures shown below is (S)-ibuprofen ?

(a) O, C – OH, C, CH_3, H

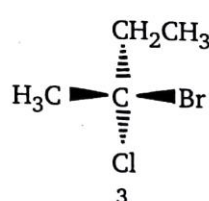
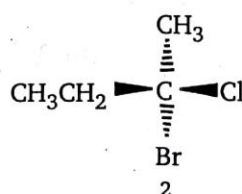
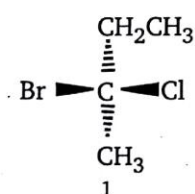
(b) H, C, C, OH, H_3C, O

(c) CH_3, C, H, C – OH, O

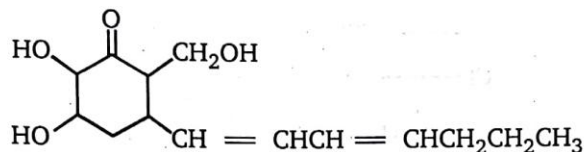
(d) O, C – OH, C, H_3C, H

70. Which of the following depict the same ?

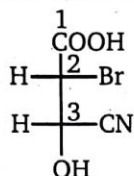
1: CH_2CH_3 (top), Br — C — Cl, CH_3 (bottom)

2: CH_3 (top), CH_3CH_2 — C — Cl, Br (bottom)

3: CH_2CH_3 (top), H_3C — C — Br, Cl (bottom)

(a) 1 and 2
(b) 1 and 3
(c) 2 and 3
(d) 1, 2, and 3

71. A naturally occurring substance has the constitution shown below. How many may have this constitution ?

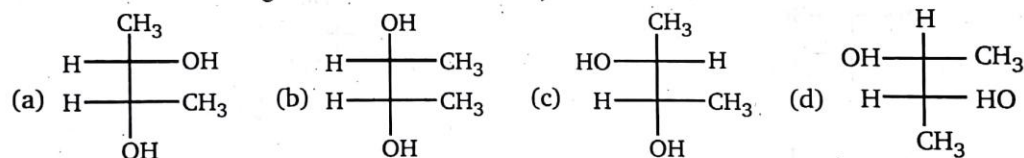
O
HO CH₂OH
HO CH = CHCH = CHCH₂CH₂CH₃

(a) 2 (b) 8 (c) 16 (d) 64

72. The absolute configurations of the two centers in the following molecule are :

(a) 2(R), 3(S) (b) 2(R), 3(R) (c) 2(S), 3(S) (d) 2(S), 3(R)

73. The total number of stereoisomer possible for 2, 3-dichloro butane :

(a) 2 (b) 3

(c) 4 (d) 5

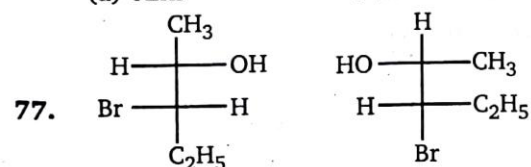
74. Which of the following structure is not meso-2,3-butanediol ?

75. A solution of optically active 1-phenylethanol racemizes in acidified aqueous medium. It is due to :

(a) enolization (b) carbonium ion formation

(c) carbanion formation (d) reversible oxidation-reduction

76. The most stable conformation of ethylene glycol is :

(a) Anti (b) Gauche (c) Partially eclipsed (d) Fully eclipsed

77.

The molecules represented by the above two structures are :

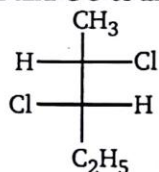
(a) identical (b) enantiomers

(c) diastereomers (d) epimers

78. The correct order of priority of groups $-SCH_3$ (I), $-NO_2$ (II), $-C\equiv CH$ (III) and $-CH_2C_6H_5$ (IV), on the basis of CIP classification, is (increasing order) :

(a) I, III, II, IV (b) IV, III, II, I

(c) II, IV, I, III (d) III, IV, II, I

79. The configuration at C-2 and C-3 of the compound given :

(a) 2R, 3S (b) 2S, 3R (c) 2S, 3S (d) 2R, 3R

80. Amongst the following amino acids, the (R) - enantiomer is represented by :

(a)

(b) COOH (top), H (left), NH_2 (right), CH_3 (bottom)

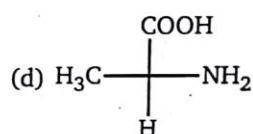
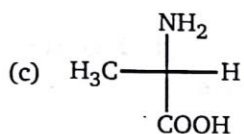
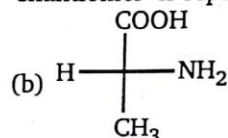
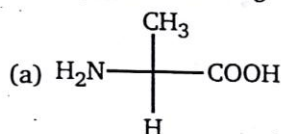
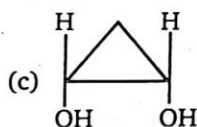
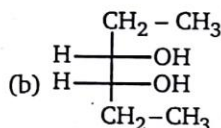
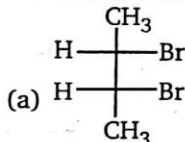
(c)

(d) COOH (top), H_3C (left), NH_2 (right), H (bottom)

81. Which of the following is a meso compound ?

(a)

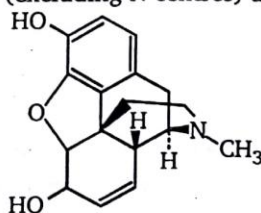
(b) CH_2-CH_3 (top); H — OH; H — OH; CH_2-CH_3 (bottom)

(c)

(d) All of these

82. Predict stereochemistry of product when *d* and *l*-amine reacts with *ℓ*-acid:

(a) Diastereomers (b) Meso

(c) Racemic (d) Pure Enantiomer

83. How many chiral center (excluding N centres) are there in morphine?

(a) 4 (b) 5

(c) 6 (d) More than 6

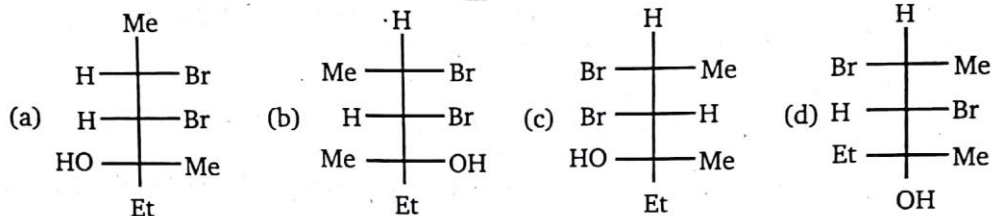
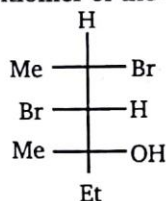
84. Which dimethylcyclobutane is optically active ?

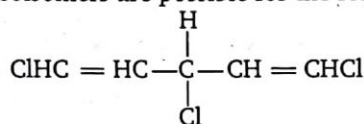
(a) *trans*-1, 2 (b) *cis*-1, 2

(c) *trans*-1, 3 (d) *cis*-1, 3

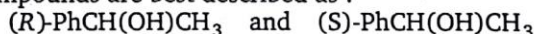
85. Which of the following is the enantiomer of the compound shown below ?

(a)
(b) H (top); Me — Br; H — Br; Me — OH; Et (bottom)

(c)
(d) H (top); Br — Me; H — Br; Et — Me; OH (bottom)

86. How many different stereoisomers are possible for the following compound ?

$$ClHC=HC-\underset{Cl}{\overset{H}{C}}-CH=CHCl$$

(a) 1 (b) 2 (c) 3 (d) 4

87. The following compounds are best described as :

(*R*)-$PhCH(OH)CH_3$ and (S)-$PhCH(OH)CH_3$

(a) enantiomers
(b) diastereomers
(c) not stereoisomers
(d) conformational isomers (differing by single bond rotation)

88. Rank the following substituent groups in order of decreasing priority according to the Cahn-Ingold-Prelog system :

$-CH(CH_3)_2$ $-CH_2Br$ $-CH_2CH_2Br$

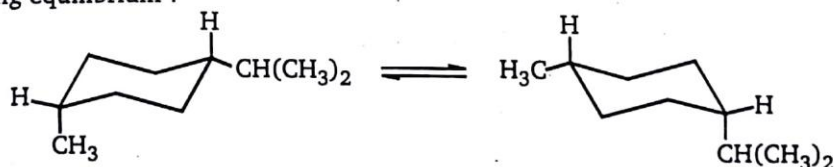
(a) 2 > 3 > 1 (b) 1 > 3 > 2 (c) 3 > 1 > 2 (d) 2 > 1 > 3

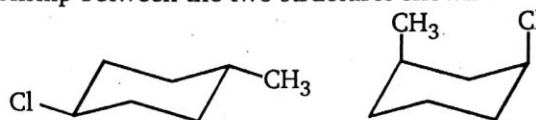
89. Compare the stabilities of the following two compounds :

A : *cis*-1-Ethyl-3-methylcyclohexane
B : *trans*-1-Ethyl-3-methylcyclohexane

(a) A is more stable (b) A and B are of equal stability
(c) B is more stable (d) No comparison can be made

90. What, if anything, can be said about the magnitude of the equilibrium constant K for the following equilibrium ?

H, $CH(CH_3)_2$, H, CH_3 ⇌ H, H_3C, H, $CH(CH_3)_2$

(a) $K = 1$ (b) $K < 1$
(c) $K > 1$ (d) No estimate of K can be made

91. What is the relationship between the two structures shown ?

(a) Constitutional isomers
(b) Stereoisomers
(c) Different drawing of the same conformation of the same compound
(d) Different conformation of the same compound

92. Which of the following statements is true ?

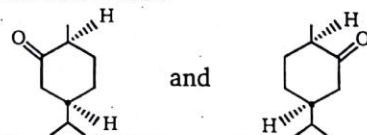
(a) van der Waals' strain in *cis*-1, 2-dimethylcyclopropane is the principal reason for its decreased stability relative to the *trans* isomer
(b) Cyclohexane gives off more heat per CH_2 group on being burned in air than any other cycloalkane
(c) The principal source of strain in the boat conformation of cyclohexane is angle strain
(d) The principal source of strain in the gauche conformation of butane is torsional strain

93. $Ph-CH=NO_2H \xrightarrow[\text{3days}]{\text{isomerises}} \underset{(50-50\%)}{(x)}$, Isomer (x) is :

(a) $Ph-NO-CH_2OH$ (b) $Ph-CH_2-NO_2$
(c) $Ph-NH-CO_2H$ (d) None

94. Which of the following will not show geometrical isomerism ?

(a) $CH_3-\underset{\underset{CH_3}{|}}{C}=CH-CH_2-CH_3$ (b) $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH=CH-CH_2-CH_3$
(c) $CH_3-CH=CH-CH_3$ (d) $CH_3-CH_2-CH=CH-CH_2-CH_3$

95. The two compounds shown below are :

(a) diastereomers (b) enantiomers (c) epimers (d) regiomers

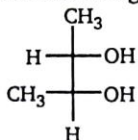
96. The molecular formula of diphenylmethane,

, is $C_{13}H_{12}$;

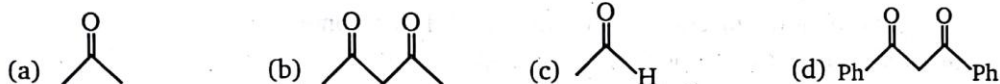
How many structural isomers are possible when one of the hydrogen is replaced by a chlorine atom ?

(a) 6 (b) 4 (c) 8 (d) 7

97. Correct configuration of the following molecule is :

$$\begin{array}{c} CH_3 \\ H-\!\!\!-\!\!\!+\!\!\!-\!\!\!-OH \\ CH_3-\!\!\!-\!\!\!+\!\!\!-\!\!\!-OH \\ H \end{array}$$

(a) 2S, 3S (b) 2S, 3R (c) 2R, 3S (d) 2R, 3R

98. Maximum enol content is in :

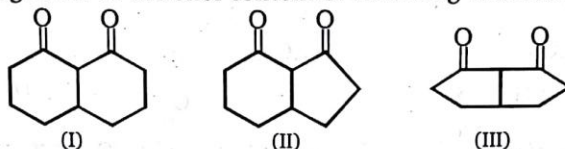
(a) (b) (c) (d)

99. Which of the following will have one of the stereoisomer meso ?

(a) 2-chlorobutane (b) 2, 3-dichlorobutane
(c) 2,3-dichloropentane (d) 2-hydroxypropanoic acid

100. The correct decreasing order in the enol content of following molecules is :

(I)

(II)

(III)

(a) I > II > III (b) II > I > III (c) III > II > I (d) II > III > I

101. Total number of stereoisomers of the compound 1-bromo-3-chlorocyclobutane is:

(a) 0 (b) 1 (c) 2 (d) 3

102. Total number of stereoisomers of the 1,3-dichlorocyclohexane is:

(a) 0 (b) 1 (c) 3 (d) 4

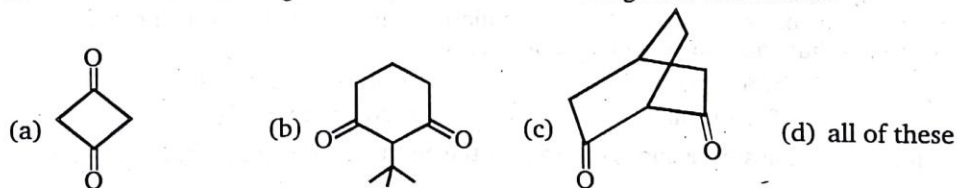
103. Total number of stereoisomers of the compound 1, 4-dichlorocyclohexane is :

(a) 0 (b) 1 (c) 2 (d) 4

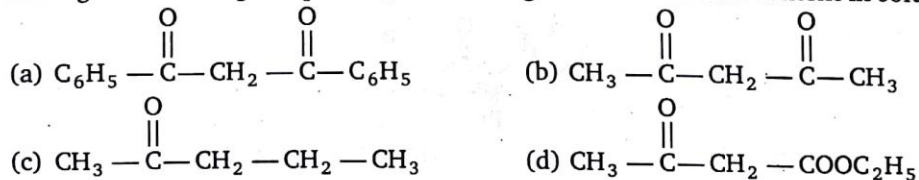
104. Total number of stereoisomers of the compound 2-4-dichloroheptane is:

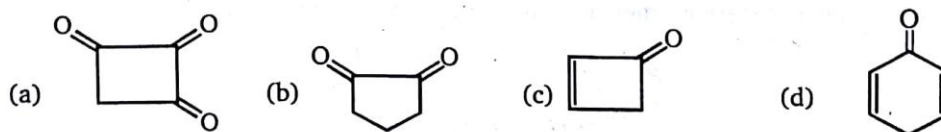
(a) 0 (b) 2 (c) 3 (d) 4

105. In which of the following keto form is more dominating than enol form:

(a) (b) (c) (d) all of these

106. Among the following compounds, which will give maximum enol content in solution :

(a) $C_6H_5-\overset{O}{\overset{||}{C}}-CH_2-\overset{O}{\overset{||}{C}}-C_6H_5$ (b) $CH_3-\overset{O}{\overset{||}{C}}-CH_2-\overset{O}{\overset{||}{C}}-CH_3$

(c) $CH_3-\overset{O}{\overset{||}{C}}-CH_2-CH_2-CH_3$ (d) $CH_3-\overset{O}{\overset{||}{C}}-CH_2-COOC_2H_5$

107. Which of the following has unstable enol form ?

(a) (b) (c) (d)

108. Calculate enantiomeric excees of mixture containing 6g of (+) 2-butanol and 4g of (–) -2-butanol.

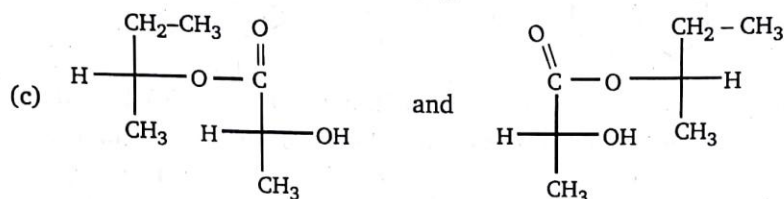
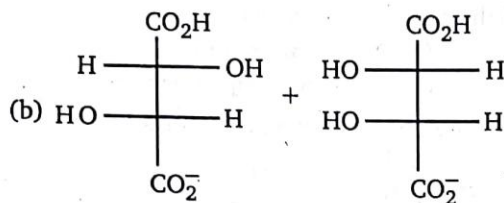
(a) 10% (b) 20% (c) 40% (d) 33%

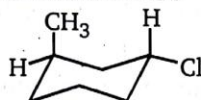
109. Which of the following pair represent pair of diastereomers ?

(a) Meso tartaric acid and (*l*) tartaric acid

(b)

(c) and

CH_2-CH_3, O, C, O, H, H, OH, CH_3, CH_3

(d) All of these

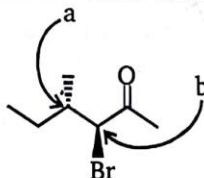
110. The stereochemistry of this molecule is :

(a) 1R, 3R (b) 1R, 3S (c) 1S, 3S (d) 1S, 3R

111. Pure (S)-2-butanol has a specific rotation of +13.52 degrees. A sample of 2-butanol prepared in the lab and purified by distillation has a calculated specific rotation of +6.76 degrees. What can you conclude about the composition ?

(a) 50% (S), 50% impurity (b) 50% (S), 50% (R)

(c) 50% (S), 50% racemic (d) some other mixture

112. Determine the absolute configurations of the chiral centres in the following compound.

a O b Br

(a) a = R; b = S (b) a = R; b = R

(c) a = S; b = S (d) a = S; b = R

113. Total number of stereoisomers possible for following compound is :

(a) 8 (b) 16 (c) 32 (d) 64

114. Which is the correct structure of D-glyceraldehyde ?

(a) Fischer projection: top CHO, left H, right OH, bottom CH_2OH

(b) Fischer projection: top H, left HO, right CHO, bottom CH_2OH

(c) Fischer projection: top CH_2OH, left HO, right H, bottom CHO

(d) All of these

115. $HO-\underset{(3)}{CH_2}-\underset{(2)}{CH_2}-\underset{(1)}{\overset{\overset{O}{\|}}{C}}-H$

Which conformer of above compound is most stable (consider conformer across (C_2-C_3))

(a) Staggered (b) Gauche (c) Fully eclipsed (d) Partially eclipsed

116.

(D) & (L) Configuration of above carbohydrate is :

(a) L, L, D (b) L, D, L (c) L, L, L (d) L, D, D

117. How many isomers have the name bromomethylcyclopentane ? (ignoring chirality)

(a) 4 (b) 5 (c) 6 (d) 7

118. Which of the following compound can show geometrical isomerism ?

(a) $(Br)(I)C=C(Cl)(Cl)$

(b) cyclopentylidene$=C(CH_3)(CH_3)$

(c) $(F)(Cl)C=C(Et)(Et)$

(d)

119. Which of the following structure represent meso-compound ?

(a) (c)

(b)

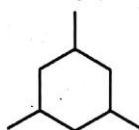
(d)

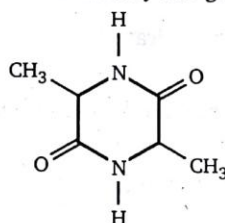
120.

$$\begin{array}{c} CO_2H \\ H - \!\!\!\! + \!\!\!\! - OH \\ CH_3 \end{array}$$

How many representations of lactic acid are possible in Fischer projection (*d* & *l*) ?

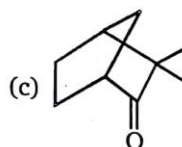
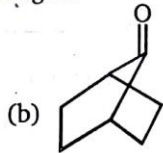
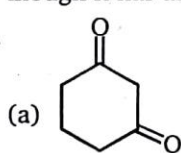
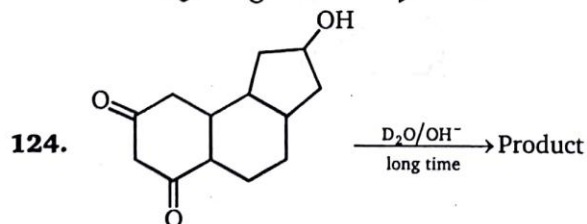
(a) 8 (b) 12
(c) 24 (d) 36

121. Total number of stereoisomer formed by the given compound is :

(a) 2 (b) 3
(c) 4 (d) 8

122. The number of stereoisomers formed by the given compound is :

(a) 2 (b) 3
(c) 4 (d) 5

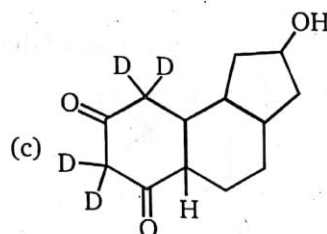
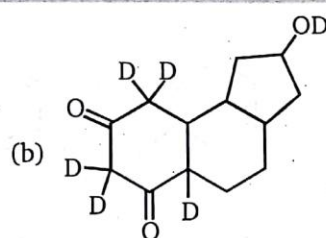
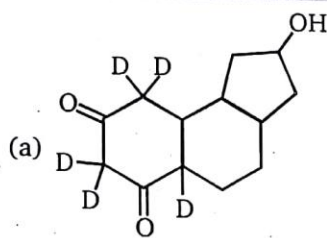
123. Which of the following compound does not undergo base - catalyzed exchange in D_2O even though it has an α-hydrogen?

(a) (b) (c) (d) both (b) & (c)

124. $\xrightarrow[\text{long time}]{D_2O/OH^-}$ Product

Identify the product formed in the above reaction:

(a)

(b)

(c)

(d) None of these

125. In 3-methyl-2-cyclohexenone which hydrogen cannot undergo deuterium exchange when it reacts with $CH_3O^{\ominus}/CH_3OD$?

(a) H_1, H_4

(b) H_4

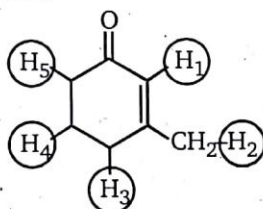
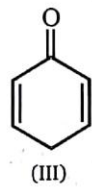
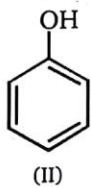
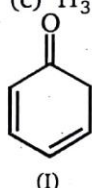
(c) H_3, H_2

(d) H_5, H_3

126.

(I)

(II)

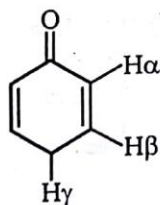
(III)

The tautomer of II is :

(a) I

(b) III

(c) both I and III

(d) none of these

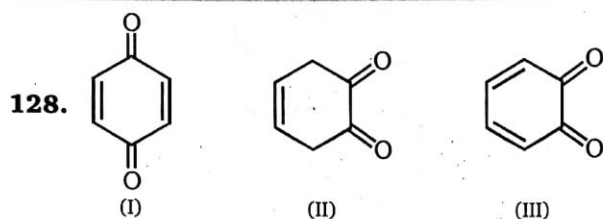
127.

In the enolization of the given molecule, the H-atom involved is :

(a) α-H

(b) β-H

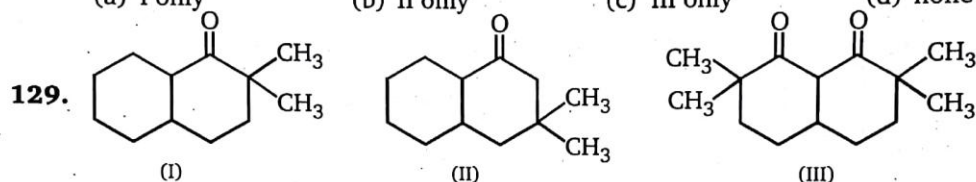
(c) γ-H

(d) cannot be enolized

128.

Among the given structure which can exhibit tautomerism ?

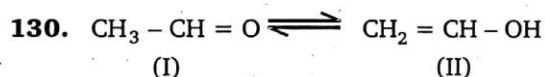
(a) I only (b) II only (c) III only (d) none of these

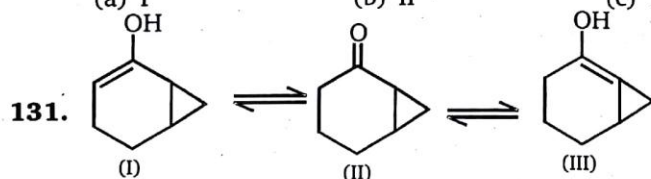
129.

(III)

Identify the which can exhibit tautomerism ?

(a) I only (b) II only (c) III only (d) all of these

130. $CH_3-CH=O \rightleftharpoons CH_2=CH-OH$

(I) (II)

Between the two tautomers which is more stable ?

(a) I (b) II (c) I = II (d) none of these

131.

(I) (II) (III)

Correct stability order of the given tautomers is :

(a) I > II > III (b) III > II > I (c) II > I > III (d) II > III > I

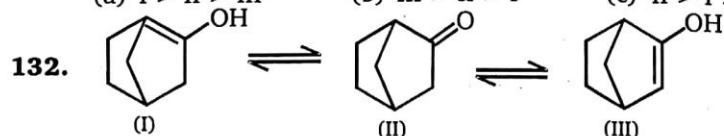
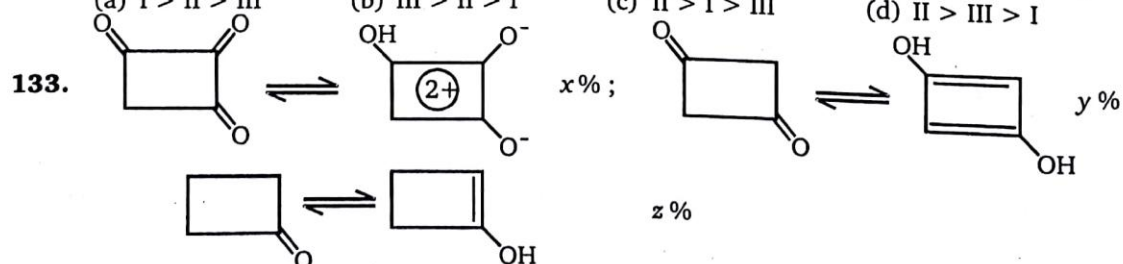
132.

(I) (II) (III)

Correct stability order of the given tautomers is :

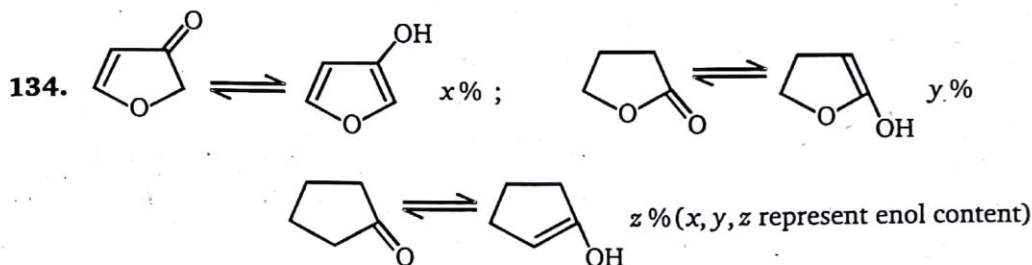
(a) I > II > III (b) III > II > I (c) II > I > III (d) II > III > I

133. x% ;

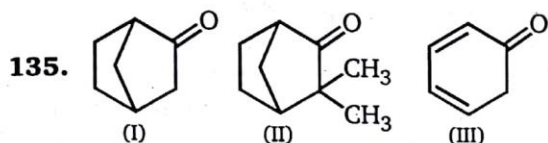
z%

The correct order of enol contents x, y, z is :

(a) $x > y > z$ (b) $z > y > x$ (c) $y > x > z$ (d) $x > z > y$

134. $\rightleftharpoons$ OH $x\%$; $\rightleftharpoons$ OH $y\%$

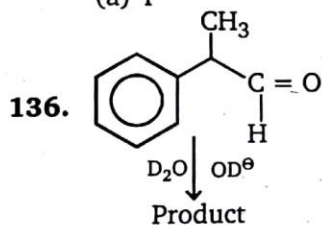
$\rightleftharpoons$ OH $z\%$ (x, y, z represent enol content)

The correct order of x, y, z is :

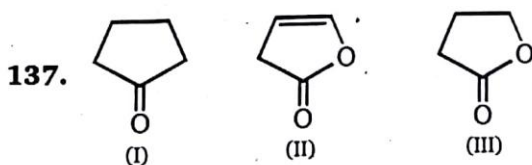
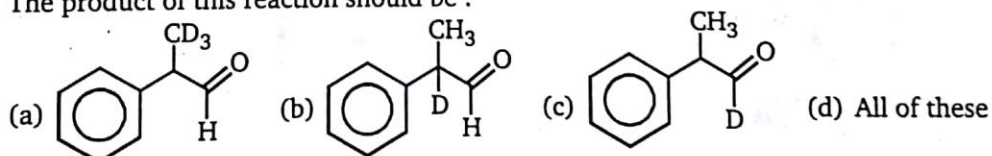
(a) $x > y > z$ (b) $z > y > x$ (c) $y > x > z$ (d) $x > z > y$

135. (I) (II) CH_3 CH_3 (III)

Among the given ketones, the one which does not enolize is :

(a) I (b) II (c) III (d) none of these

136. CH_3 C = O H

D_2O | $OD^{\ominus}$

Product

The product of this reaction should be :

(a)

(b)

(c)

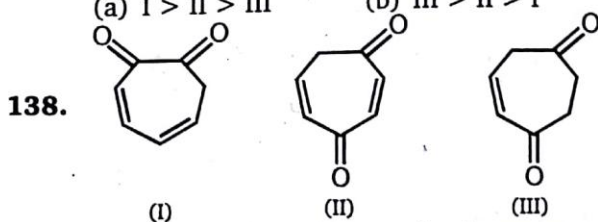
(d) All of these

137.

(III)

Among the given compounds, the correct order of enol content is :

(a) I > II > III (b) III > II > I (c) II > I > III (d) II > III > I

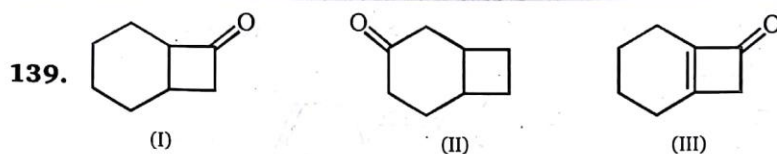
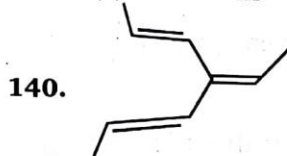
138. (I)

Among the given compounds, the correct order of enol content is :

(a) I > II > III (b) III > II > I (c) II > I > III (d) II > III > I

139. (I) (II) (III)

Among the given compounds, the correct order of enol content is :

(a) I > II > III (b) III > II > I (c) III > I > II (d) II > I > III

140.

How many geometrical isomers are possible for the above compound ?

(a) 3 (b) 4 (c) 6 (d) 8

141. Which of the following compound will not show geometrical isomerism across the π-bond ?

(a)

(b)

(c)

(d) F F I I

142. H, H $\searrow$ C = C = C $\swarrow$ H, H (l_1, l_2)

Choose the correct relation between l_1 and l_2 ?

(a) $l_1 = l_2$ (b) $l_1 > l_2$ (c) $l_1 < l_2$ (d) $l_2 = 2l_1$

143. H, H $\searrow$ C = C = C = C $\swarrow$ H, H (l_1, l_2)

Choose the correct relation between l_1 and l_2 ?

(a) $l_1 = l_2$ (b) $l_1 > l_2$ (c) $l_1 < l_2$ (d) $l_2 = 2l_1$

144. CH_3, CH_3

How many geometrical isomers are possible for the above compound ?

(a) 0 (b) 2 (c) 3 (d) 4

145. CH_3 / C_2H_5 (1-ethyl-2-methylcyclohexane ring)

How many geometrical isomers are possible for the above compound ?

(a) 0 (b) 2 (c) 3 (d) 4

146.

How many geometrical isomers are possible for the above compound ?

(a) 0 (b) 2 (c) 3 (d) 4

147. CH_3 / Br

How many geometrical isomers are possible for the above compound ?

(a) 0 (b) 2 (c) 3 (d) 4

148. CH_3 / CH_3 / CH_3

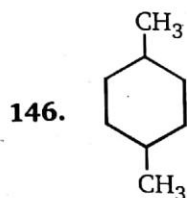
How many geometrical isomers are possible for the above compound ?

(a) 0 (b) 2 (c) 3 (d) 4

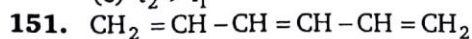
149. CH_3 / CH_3

How many geometrical isomers are possible for the above compound ?

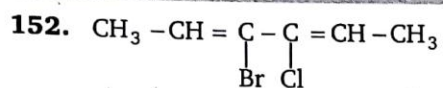
(a) 0 (b) 2 (c) 3 (d) 4

150. (I): $CH_3(H)C=C=C=C(CH_3)H$, with l_1 the distance between the two CH_3 groups; (II): $CH_3(H)C=C=C=C(H)CH_3$, with l_2 the distance between the two CH_3 groups

I and II are geometrical isomers of each other because

(a) $l_1 = l_2$ (b) $l_1 > l_2$

(c) $l_2 > l_1$ (d) l_1 and l_2 cannot be compared.

151. $CH_2 = CH - CH = CH - CH = CH_2$

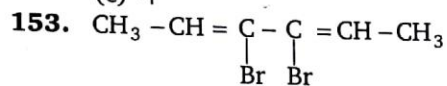
How many geometrical isomers are possible for this compound ?

(a) 2 (b) 3 (c) 4 (d) 8

152. $CH_3-CH=\underset{\displaystyle Br}{\underset{|}{C}}-\underset{\displaystyle Cl}{\underset{|}{C}}=CH-CH_3$

How many geometrical isomers are possible for this compound?

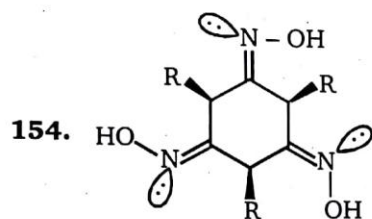
(a) 2 (b) 3

(c) 4 (d) 6

153. $CH_3-CH=\underset{\displaystyle Br}{\underset{|}{C}}-\underset{\displaystyle Br}{\underset{|}{C}}=CH-CH_3$

How many geometrical isomers of this compound are possible ?

(a) 2 (b) 3

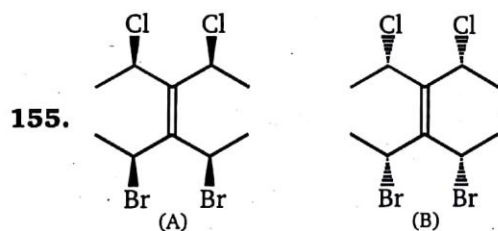
(c) 4 (d) 6

154.

(a) chiral (b) C_3 axis of symmetry

(c) Optically active (d) All of these

155.

(A)

(B)

Relationship between above pair (A) & (B) is :

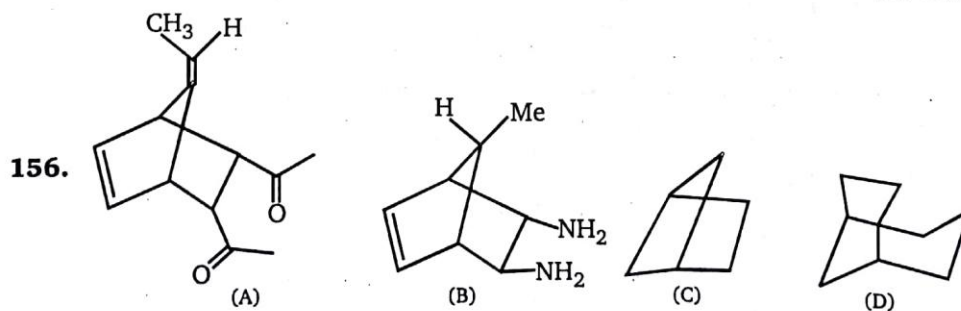
(a) Enantiomer (b) Diastereomers (c) Identical (d) Structural isomer

156.

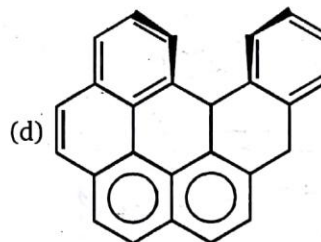
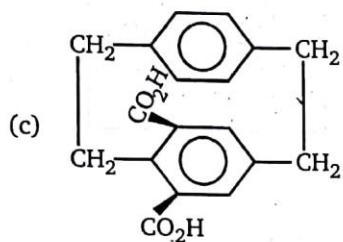
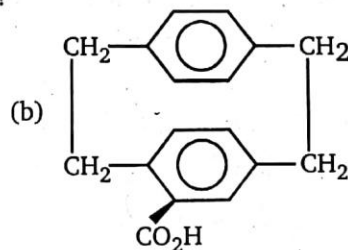
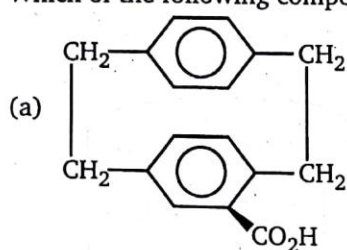
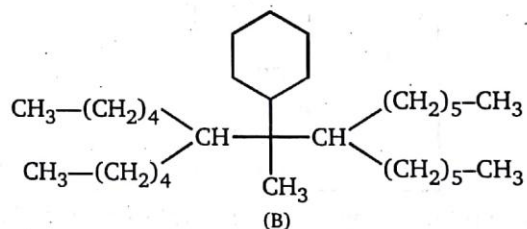
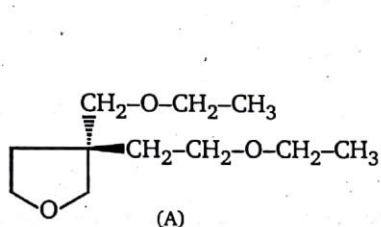
(A)

(B)

(C)

(D)

From the above compound (*A*), (*B*), (*C*) & (*D*) chiral compound is :

(a) *A* (b) *B* (c) *C* (d) *D*

157. Which of the following compound is achiral ?

R and S configuration of compound (A) & (B) will be :

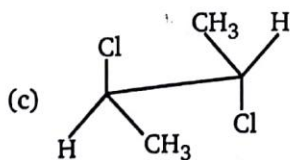
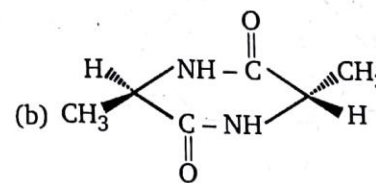
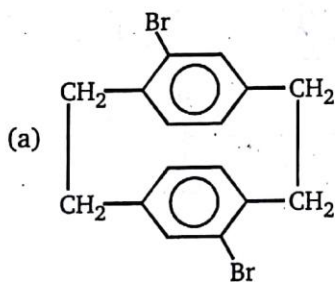
(a) R, R (b) R, S

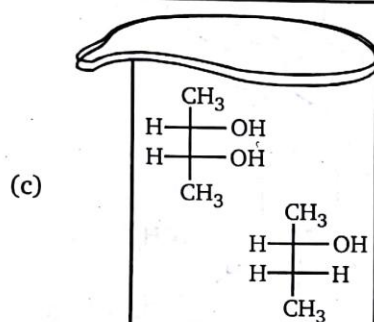
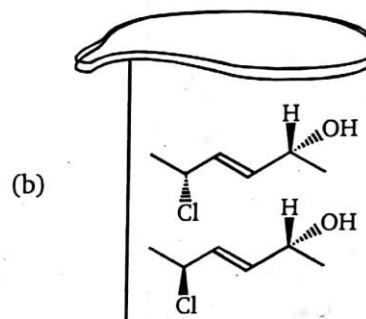
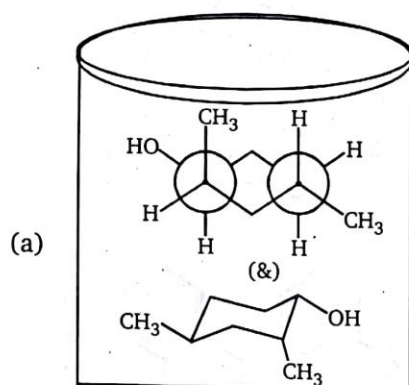
(c) S, R (d) S, S

159. Which of following compound has center of symmetry?

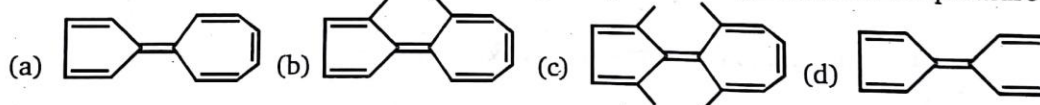
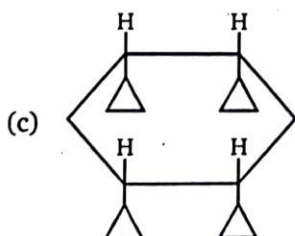
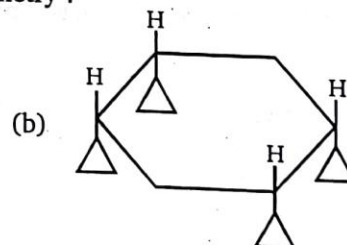
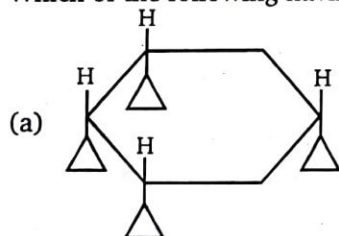
(a) [structure: CH_2-bridged cyclophane with two Br substituents]

(b) [structure: H, CH_3, NH – C(=O), C(=O) – NH, CH_3, H]

(c) [structure: Cl, H, CH_3; CH_3, H, Cl]

(d) All of these

160. Which mixture of structure in each beaker would rotate plane polarized light ?

(a) (b) (c) (d) All of these

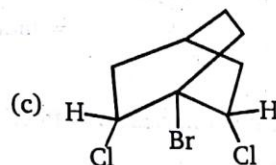
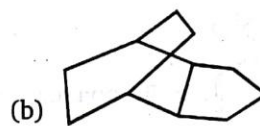
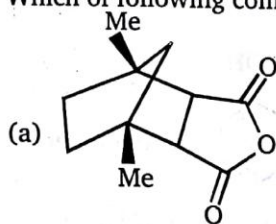
161. Which of following compound will rotate the plane polarized light at room temperature?

(a) (b) (c) (d)

162. Which of the following having plane of symmetry ?

(a) (b) (c) (d) All of these

163. Which of following compound is achiral ?

(a)

(b)

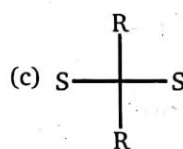
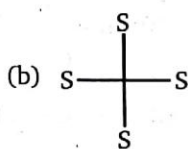
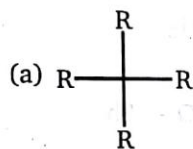
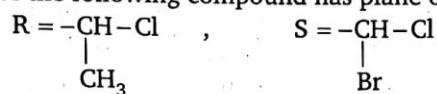
(c)

(d) All of these

164. Which of the following compound has plane of symmetry ?

R = –CH–Cl (with CH_3 below CH) , S = –CH–Cl (with Br below CH)

(a) R, R, R, R (Fischer projection: R top, R left, R right, R bottom)

(b) S, S, S, S (Fischer projection: S top, S left, S right, S bottom)

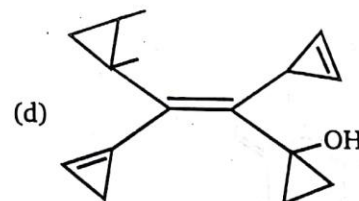
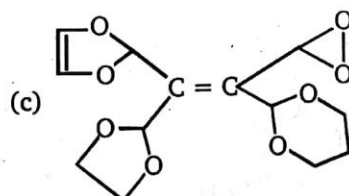
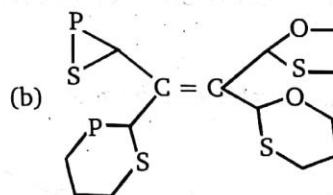
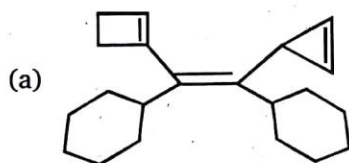
(c)

(d) None of these

165. Which of following is E isomer ?

(a)

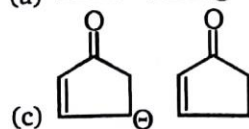
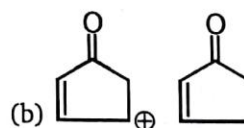
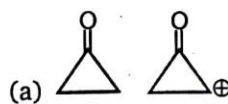
(b)

(c)

(d)

166. Among the given pairs, in which pair second compound has less enol content than first compound?

(a)

(b)

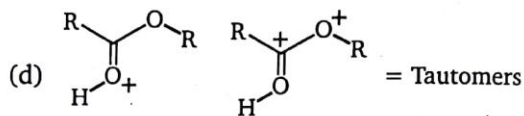
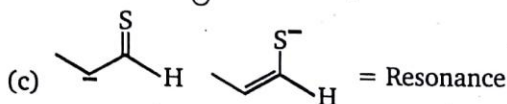
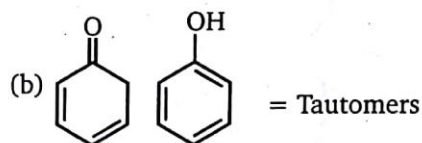
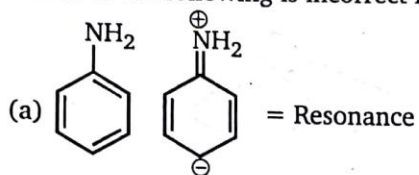
(c)

(d) none of these

167. Which of the following is incorrect relation between given pairs ?

(a) Aniline (NH_2) and ($\overset{\oplus}{N}H_2$, ring with $\ominus$) = Resonance

(b) (Cyclohexadienone, O) and (Phenol, OH) = Tautomers

(c) (S, H) and (S^-, H) = Resonance

(d) (R, O, R, $\overset{+}{O}$, H) and (R, +, O^+, R, O, H) = Tautomers

168. $Ph-\underset{\underset{OH}{|}}{CH}-\overset{\overset{O}{||}}{C}-H \xrightarrow[H_2O]{HO^{\ominus}} (B)$; (A) and (B) are isomer and isomerization effectively

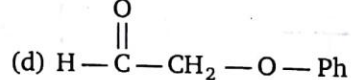
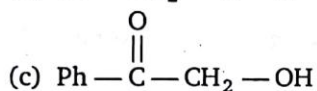
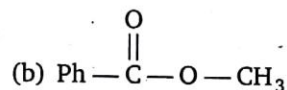
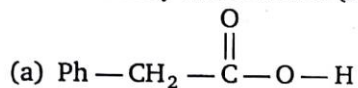
(A)

carried out by trace of base (B). Identify (B).

(a) $Ph-CH_2-\overset{\overset{O}{||}}{C}-O-H$

(b) $Ph-\overset{\overset{O}{||}}{C}-O-CH_3$

(c) $Ph-\overset{\overset{O}{||}}{C}-CH_2-OH$

(d) $H-\overset{\overset{O}{||}}{C}-CH_2-O-Ph$

169. $CH_3-CH=CH-CH=CH-CH_3$; total number of geometrical isomer is :

(a) 2

(b) 3

(c) 4

(d) 6

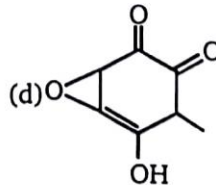
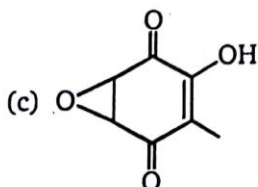
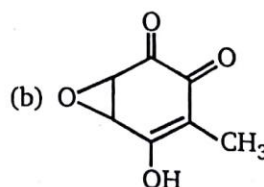
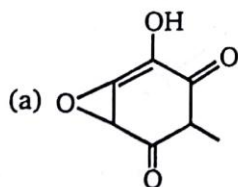
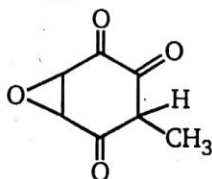
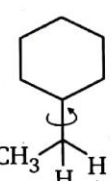
170. Identify most stable enol form of terric acid:

(Structure: O, O, O, H, CH_3, O)

(a) (O, OH, O, O)

(b) (O, O, O, CH_3, OH)

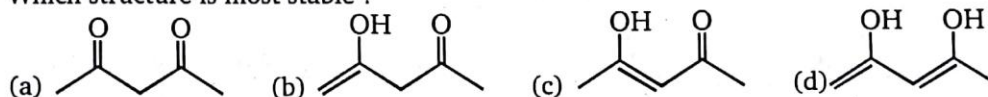
(c) (O, O, OH, O)

(d) (O, O, O, OH)

171. Which structure is most stable ?

(a)

(b)

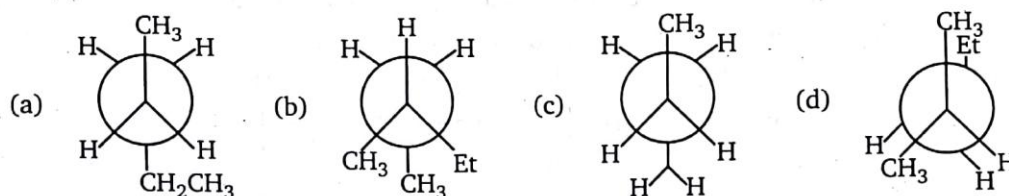
(c)

(d)

172. Identify conformer of 2-methly pentane :

(a)

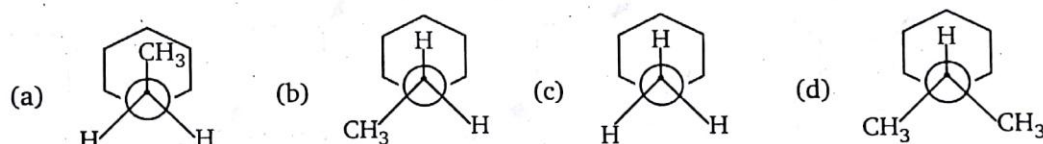
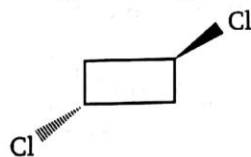
(b)

(c)

(d)

173. The lowest energy conformer of is:

(a)

(b) (c)

(d)

174.

How many atoms will be bisect during plane of symmetry ?

(a) 2 (b) 4 (c) 6 (d) 8

175. The number of all types of isomers of chlorobutane is :

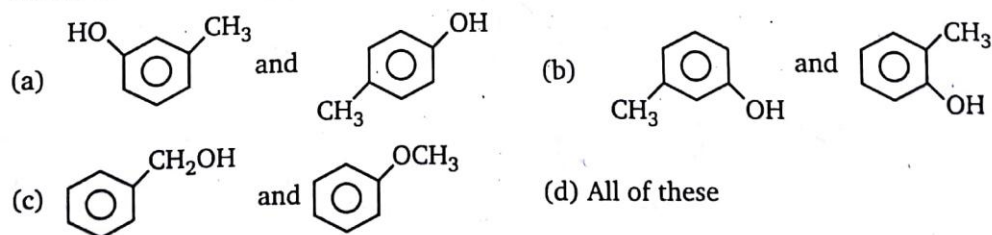
(a) 2 (b) 4 (c) 6 (d) 5

176. Which of the following pairs of compounds are not positional isomers ?

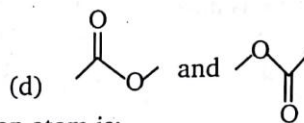
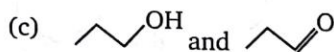
(a)

(b)

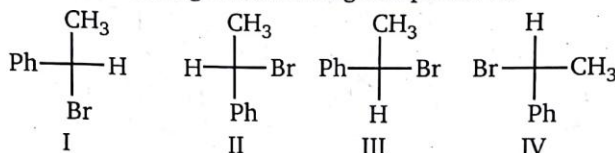
(c)

(d) All of these

177. Which of the following pairs of compounds are functional isomers ?

(a) and

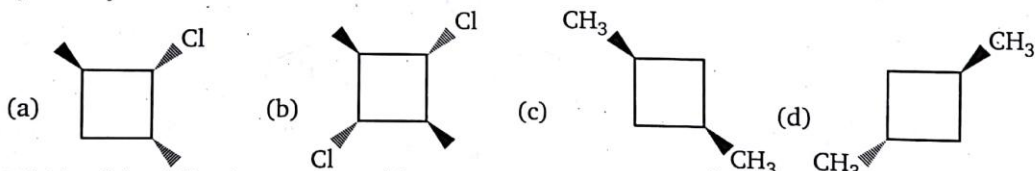
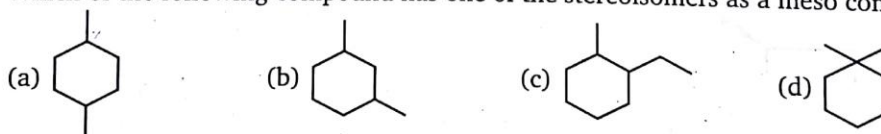
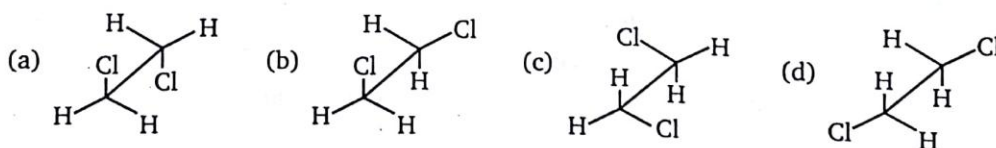
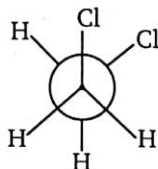
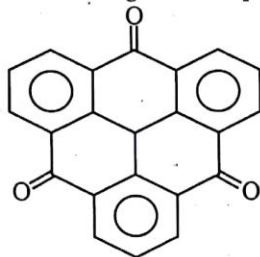
(b)

178. The isomeric alcohol which has a chiral carbon atom is:

(a) *n*-butyl alcohol (b) *iso*-butyl alcohol (c) *sec*-butyl alcohol (d) *tert*-butyl alcohol

179. The pair of enantiomers among the following compound is:

(a) I and IV (b) II and IV (c) II and III (d) I and II

180. Which of the following is chiral?

(a) Cell phone (b) Spiral staircase (c) Scissor (d) All of these

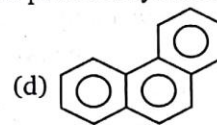
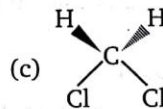
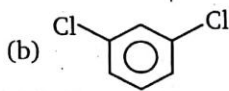
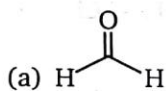
181. In which of the following compound, possess plane of symmetry as well as centre of symmetry?

182. Which of the following compound has one of the stereoisomers as a meso compound?

183. For the following Newman projection

184. Which of the following is correct for the given compound?

(a) It possess centre of symmetry
(b) It possess C_4 axis of symmetry
(c) It possess plane of symmetry
(d) Compound is chiral

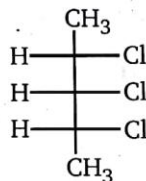
185. Which of the following molecules has axis of symmetry and a coaxial plane of symmetry?

(a)

(b)

(c)

(d)

(e) All of these

186. Number of diastereomer of given compound :

(a) 2
(b) 3
(c) 4
(d) 6

187. Which of the structures is/are diastereomer of **A** ?

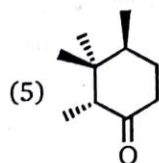
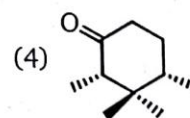
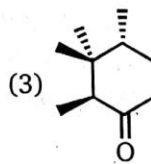
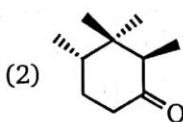
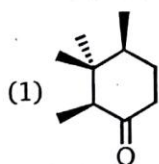
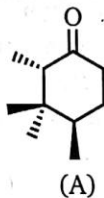
(A)

(1)

(2)

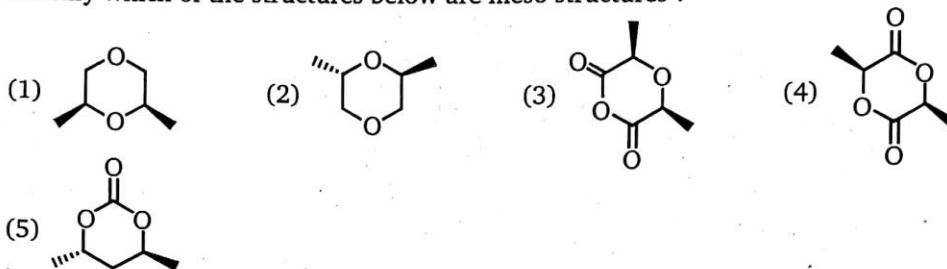
(3)

(4)

(5)

(a) 3
(b) 1 and 4
(c) 2 and 3
(d) 5

188. Identify which of the structures below are meso structures ?

(1) (2) (3) (4)

(5)

(a) 1 and 3 (b) 1,3 and 5 (c) 1,3 and 4 (d) 2 and 5

189. How many enol form is possible for $CH_3-CH_2-\overset{O}{\overset{\|}{C}}-CH_2-CH_2-CH_3$ (including stereoisomers) will be ?

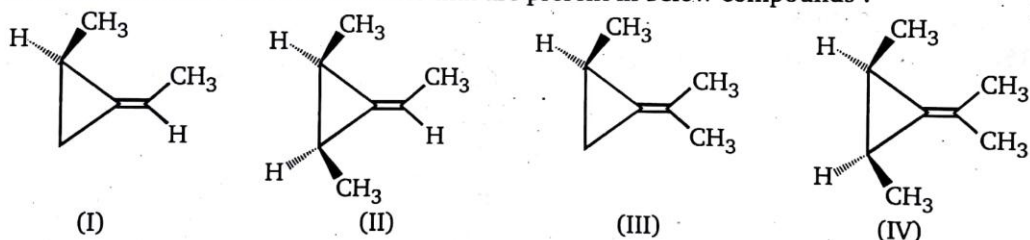
(a) 2 (b) 3 (c) 4 (d) 5

190. Find the sum of all the stereocenters that are present in below compounds :

(I)

(II)

(III)

(IV)

(a) 8 (b) 9 (c) 10 (d) 11

191. A pair of stereoisomers might be classified in various ways. Which of the following statement are true with respect to pairs of stereoisomers ?

(a) They might be configurational isomers (b) They might be diastereomers
(c) They might be constitutional isomers (d) They might be tautomers
(e) They might be conformational isomers (f) They might be enantiomers
(g) They might be positional isomers

(a) a, b, c, e (b) b, d, e, f, g (c) a, b, f (d) a, b, c, f

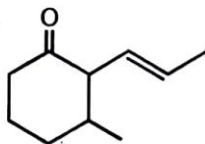
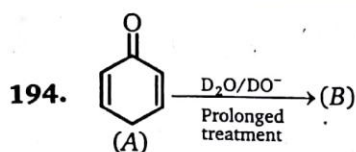
192. Ignoring specific markings, which of the following objects are chiral ?

(I) a shoe (II) a book (III) a pencil
(IV) a pair of shoes (consider the pair as one object)
(V) a pair of scissors

(a) I only (b) I & V (c) I, IV, V (d) III, IV, V

193. Calculate the total number of stereoisomers when alkene having trans configuration :

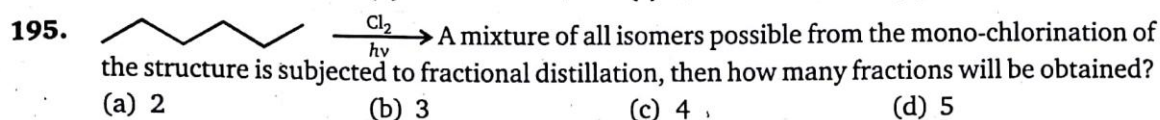
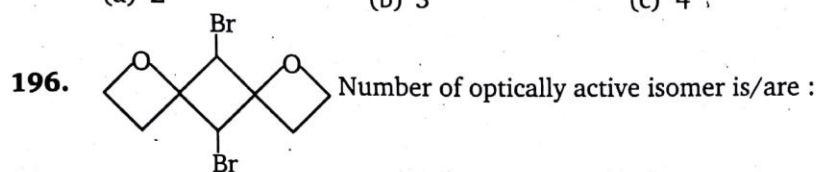
(a) 2 (b) 3 (c) 4 (d) 8

194. (A) $\xrightarrow[\text{Prolonged treatment}]{D_2O/DO^-}$ (B)

After prolonged treatment of (A) by D_2O/DO^-, the difference in molecular weights of compounds (A) and (B) is :

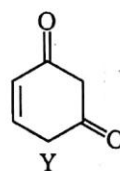
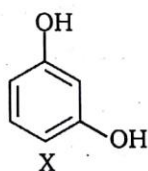
(a) 2 (b) 3 (c) 4 (d) 8

195. $\xrightarrow[h\nu]{Cl_2}$ A mixture of all isomers possible from the mono-chlorination of the structure is subjected to fractional distillation, then how many fractions will be obtained?

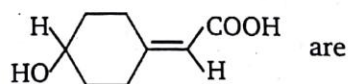
(a) 2 (b) 3 (c) 4 (d) 5

196. Br Br Number of optically active isomer is/are :

(a) 0 (b) 1 (c) 2 (d) 3

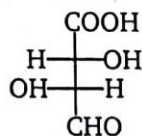
197. At normal temperature, X and Y

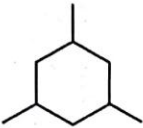
OH OH X O O Y

(a) resonance structures (b) tautomers
(c) functional isomers (d) positional isomers

198. Two possible stereoisomers for

H HO COOH H are

(a) enantiomers (b) diastereomers (c) conformers (d) rotamers

199. The configurations of the carbon atoms C_2 and C_3 in the following compound are respectively

COOH
H—OH
OH—H
CHO

(a) R, R (b) S, S (c) R, S (d) S, R

200. The compound that is chiral is

(a) 3-methyl-3-hexene (b) 4-chloro-1-methycyclohexane
(c) 2-phenylpentane (d) 1, 3-disopropylbenzene

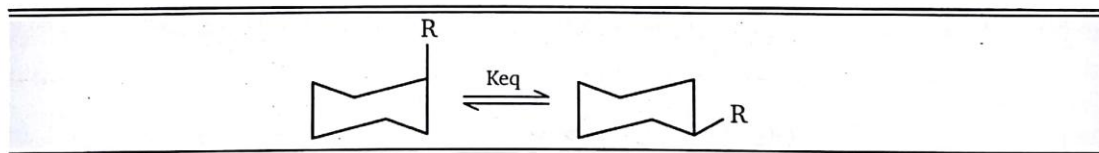
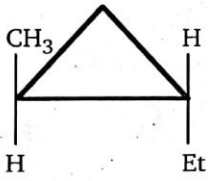
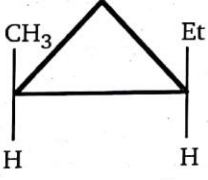
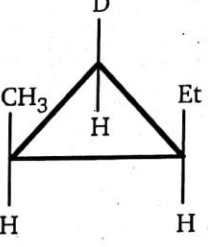
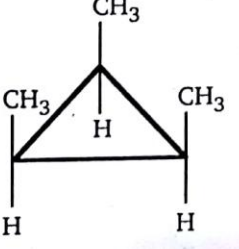
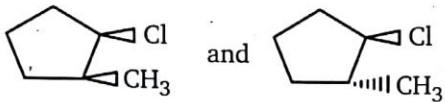
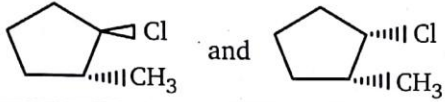
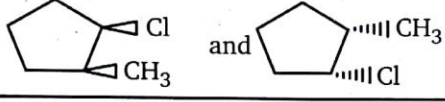
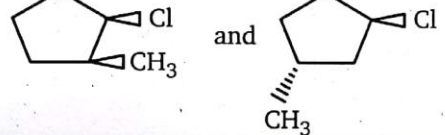
ANSWERS – LEVEL 1

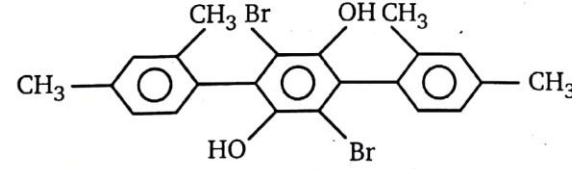
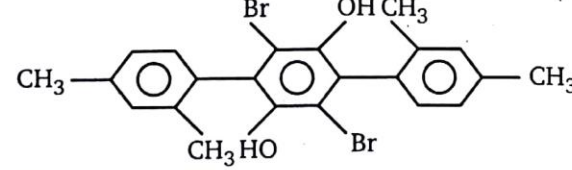
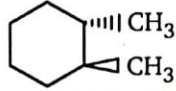
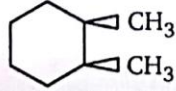
1.	(b)	2.	(c)	3.	(b)	4.	(c)	5.	(a)	6.	(b)	7.	(c)	8.	(d)
9.	(c)	10.	(d)	11.	(b)	12.	(c)	13.	(a)	14.	(b)	15.	(b)	16.	(d)
17.	(c)	18.	(a)	19.	(b)	20.	(b)	21.	(d)	22.	(b)	23.	(c)	24.	(d)
25.	(a)	26.	(b)	27.	(d)	28.	(b)	29.	(a)	30.	(c)	31.	(c)	32.	(a)
33.	(b)	34.	(c)	35.	(c)	36.	(d)	37.	(c)	38.	(d)	39.	(b)	40.	(a)
41.	(a)	42.	(d)	43.	(a)	44.	(d)	45.	(a)	46.	(b)	47.	(c)	48.	(b)
49.	(c)	50.	(c)	51.	(d)	52.	(d)	53.	(e)	54.	(a)	55.	(d)	56.	(c)
57.	(d)	58.	(b)	59.	(a)	60.	(a)	61.	(c)	62.	(d)	63.	(e)	64.	(d)
65.	(b)	66.	(b)	67.	(d)	68.	(d)	69.	(d)	70.	(d)	71.	(d)	72.	(a)
73.	(b)	74.	(a)	75.	(b)	76.	(b)	77.	(a)	78.	(b)	79.	(c)	80.	(b)
81.	(d)	82.	(a)	83.	(b)	84.	(a)	85.	(a)	86.	(d)	87.	(a)	88.	(d)
89.	(a)	90.	(b)	91.	(a)	92.	(a)	93.	(b)	94.	(a)	95.	(b)	96.	(b)
97.	(a)	98.	(d)	99.	(b)	100.	(a)	101.	(c)	102.	(c)	103.	(c)	104.	(d)
105.	(d)	106.	(a)	107.	(c)	108.	(b)	109.	(d)	110.	(a)	111.	(c)	112.	(c)
113.	(a)	114.	(d)	115.	(b)	116.	(b)	117.	(c)	118.	(d)	119.	(b)	120.	(c)
121.	(a)	122.	(b)	123.	(d)	124.	(b)	125.	(b)	126.	(c)	127.	(c)	128.	(b)
129.	(d)	130.	(a)	131.	(c)	132.	(d)	133.	(d)	134.	(d)	135.	(b)	136.	(b)
137.	(c)	138.	(a)	139.	(d)	140.	(b)	141.	(b)	142.	(a)	143.	(c)	144.	(b)
145.	(b)	146.	(b)	147.	(b)	148.	(a)	149.	(b)	150.	(c)	151.	(a)	152.	(c)
153.	(b)	154.	(d)	155.	(c)	156.	(a)	157.	(c)	158.	(d)	159.	(d)	160.	(d)
161.	(b)	162.	(d)	163.	(d)	164.	(d)	165.	(d)	166.	(c)	167.	(d)	168.	(c)
169.	(b)	170.	(c)	171.	(c)	172.	(d)	173.	(b)	174.	(c)	175.	(d)	176.	(c)
177.	(b)	178.	(c)	179.	(c)	180.	(d)	181.	(d)	182.	(b)	183.	(b)	184.	(c)
185.	(e)	186.	(b)	187.	(b)	188.	(a)	189.	(c)	190.	(c)	191.	(c)	192.	(b)
193.	(c)	194.	(c)	195.	(b)	196.	(a)	197.	(b)	198.	(a)	199.	(a)	200.	(c)

LEVEL-2

1. Match the Column (I) and (II).

	Column (I)		Column (II)
	Reaction		**Stereoisomers**
(a)	$CH_3-CH=CH-CH=N-OH$	**(p)**	2
(b)		**(q)**	4
(c)	$CH_3-CH=CH-CH=CH-CH=CH-CH_3$	**(r)**	6
(d)	$CH_3-CH=CH-CH=CH-CH=CH-Ph$	**(s)**	8

2. Match the Column (I) and (II).

	Column (I)		Column (II)
	Group		**Equilibrium Constant**
(a)	$R=-H$	**(p)**	38
(b)	$R=-CH_3$	**(q)**	23
(c)	$R=-Et$	**(r)**	18
(d)	$R=-CH(CH_3)-CH_3$	**(s)**	1

3. **Match the Column (I) and (II). (Matrix)**

	Column (I)		**Column (II)**
	Molecule		**Nature**
(a)	H, $CO_2CH_2CH_2OH$, CO_2H, H	**(p)**	Chiral
(b)	H, $CO_2CH_2CH_2O_2C$, H, $CO_2CH_2CH_2O_2C$, H, H	**(q)**	Achiral
(c)	OH, H, CO_2H, CO_2H, H, OH	**(r)**	Meso
(d)	H, CO_2H, H, HO, CO_2H, OH	**(s)**	Compound containing even number of chiral centers

4. **Match the Column (I) and (II). (Matrix)**

	Column (I)		Column (II)
	Compound		**Isomerism**
(a)	CH_3 H H Et	**(p)**	Geometrical isomerism
(b)	CH_3 Et H H	**(q)**	Optical isomerism
(c)	D CH_3 H Et H H	**(r)**	Compound containing plane of symmetry
(d)	CH_3 CH_3 H CH_3 H H	**(s)**	Compound containing center of symmetry

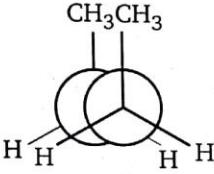
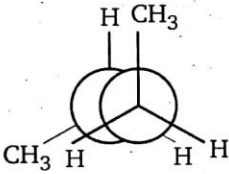
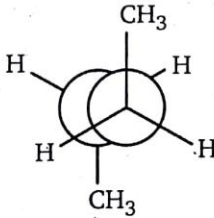
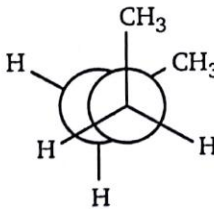
5. **Match the Column (I) and (II).**

	Column (I) Molecules		Column (II) Relationship
(a)	[structure] and [structure]	(p)	Identical
(b)	[structure] and [structure]	(q)	Enantiomer
(c)	[structure] and [structure]	(r)	Diastereomer
(d)	[structure] and [structure]	(s)	Structural Isomerism

6. **Match the Column (I) and (II). (Matrix)**

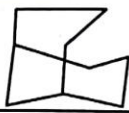
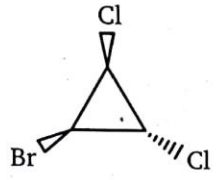
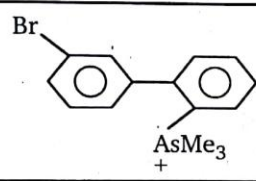
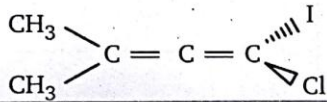
	Column (I) Compound		Column (II) Nature
(a)	[structure]	(p)	*cis*-compound
(b)	[structure]	(q)	*trans*-compound
(c)	[structure]	(r)	Optically active
(d)	[structure]	(s)	Optically inactive

7. Match the Column (I) and (II). (Matrix)

	Column (I) Molecule		Column (II) Property
(a)	H(Cl)C = C = C(H)Cl	(p)	Chiral centers containing compound
(b)	H(CH$_3$)C=C(CH$_3$)H	(q)	Presence of stereocenter
(c)	Fischer projection: Cl (top), Br (left), F (right), I (bottom)	(r)	Optically active compound
(d)	CH$_3$(Et)C=N–OH (with lone pair on N)	(s)	Compound containing plane of symmetry

8. Match the Column (I) and (II). (Matrix)

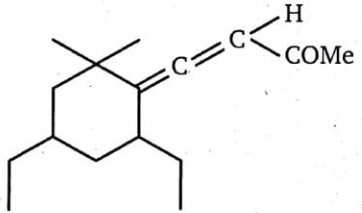
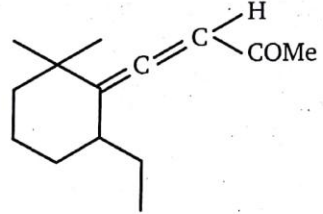
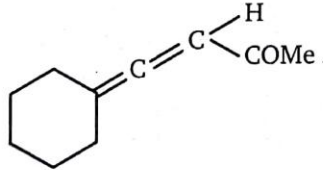
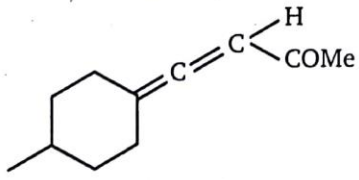
	Column (I) Molecule		Column (II) Property
(a)	F(H)C = C = C = C(H)F	(p)	Polar molecule
(b)	F(H)C = C = C(H)F	(q)	Optically active
(c)	F (wedge)–cyclohexane–(hash) F	(r)	Optically inactive
(d)	Benzene ring with H, F, H, H, H, H substituents	(s)	Plane of symmetry

9. Match the Column (I) and (II). (Matrix)

Column (I)		Column (II)	
	Molecule		**Property**
(a)	Me, H	(p)	Meso compound
(b)	Me, H, H, Me	(q)	Achiral
(c)	Me, H, H, Me	(r)	Chiral compound
(d)	Me, H, Me, Me, H, H	(s)	Compound will show geometrical isomerism

10. Match the Column (I) and (II).

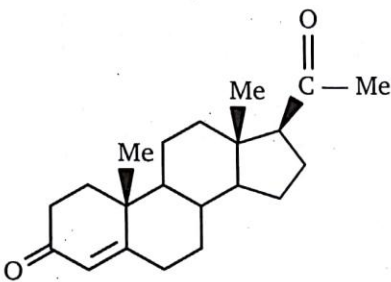
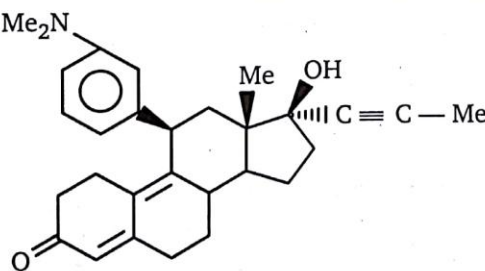
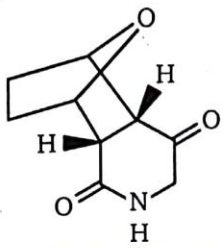
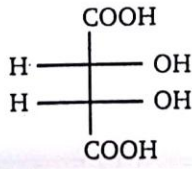
	Column (I)		Column (II)
	Modified Newmann Projection		**Conformers**
(a)	CH_3CH_3; H H H H	(p)	Fully eclipsed
(b)	H CH_3; CH_3 H H H	(q)	Partially eclipsed
(c)	CH_3; H H; H H; CH_3	(r)	Gauche
(d)	CH_3; H CH_3; H H; H	(s)	Staggered

11. Match the Column (I) and (II).

	Column (I) Newmann Projection		Column (II) Name of the Compound
(a)		(p)	3-methyl pentane
(b)		(q)	*n*-butane
(c)		(r)	Methyl-cyclopentane
(d)		(s)	1,2,4-trimethyl cyclohexane

12. Match the Column (I) and (II). (Matrix)

	Column (I) Molecule		Column (II) Property
(a)		**(p)**	Rotates plane polarized light
(b)	Cl, Br, Cl	**(q)**	Cannot rotate plane polarized light
(c)	Br, $\overset{+}{As}Me_3$	**(r)**	Plane of symmetry
(d)	$(CH_3)_2C=C=C(I)(Cl)$	**(s)**	Centre of symmetry

13. Match the Column (I) and (II).

	Column (I) Molecule		Column (II) Stereocenters
(a)	$CH_3-CH=CH-CH(Br)-CH_3$	**(p)**	1
(b)	$H-C\equiv C-CH=CH-CH(Br)-CH(Br)-CH_3$	**(q)**	2
(c)	$Ph-S(=O)-CH=CH-CH(CH_3)-CH_3$	**(r)**	3
(d)	$Ph-CH(Cl)-Et$	**(s)**	4

14. Match the Column (I) and (II).

	Column (I)		Column (II)
	Molecule		**Stereoisomers**
(a)	C=C=C(H)(COMe)	(p)	2
(b)	C=C=C(H)(COMe)	(q)	0
(c)	C=C=C(H)(COMe)	(r)	4
(d)	C=C=C(H)(COMe)	(s)	8

15. Match the Column (I) and (II). (Matrix)

	Column (I)		Column (II)
	Molecule		**Property**
(a)	Me, Me, O, C — Me, O	**(p)**	Meso Compound
(b)	Me_2N, Me, OH, C ≡ C — Me, O	**(q)**	Compound having even no. of chiral centres
(c)	O, H, O, H, O, N, H	**(r)**	Optically active compound
(d)	COOH; H — OH; H — OH; COOH	**(s)**	Compound having odd no. of chiral centres.

16. Match the Column (I), (II) and (III). (Matrix)

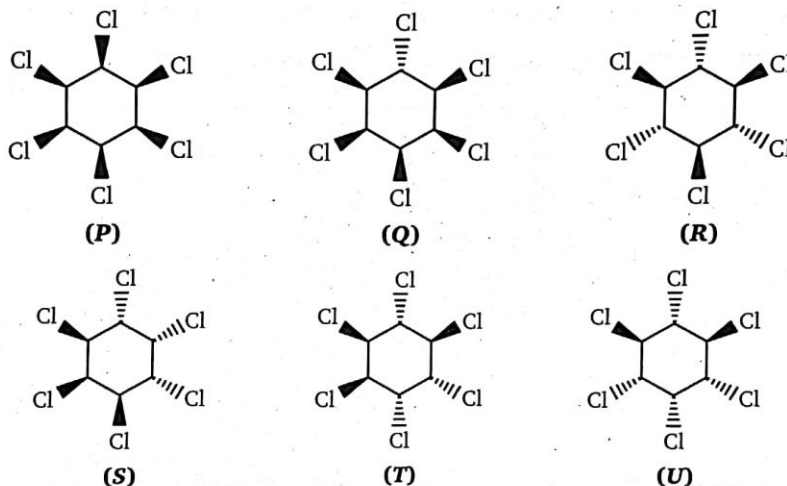
	Column (I)		Column (II)		Column (III)
	Property		Molecule		No. of Chiral Center
(a)	$CH_3(H)C=C(H)CHDCl$	(p)	Optically active	(w)	0
(b)	cyclohexane with two CH_3 (wedge)	(q)	Optically inactive	(x)	1
(c)	$CH_3-\overset{\oplus}{N}(O^{\ominus})(Et)-HCl^{\ominus}$	(r)	Plane of symmetry	(y)	2
(d)	cyclohexane with H, Cl at 1 and 4 positions	(s)	Centre of symmetry	(z)	3

17.

From the above compounds select :

(A)	two of which are chiral and contain chiral centre :	
(B)	two of which are achiral and contains chiral centre :	
(C)	two of which are chiral and does not contain chiral centre :	
(D)	two of which are achiral and does not contain chiral centre :	

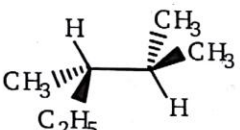
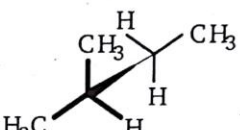
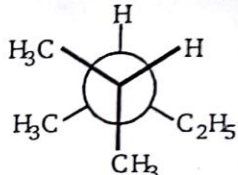
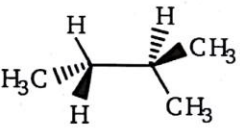
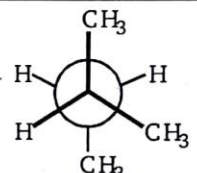
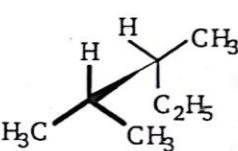
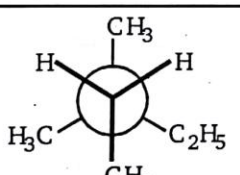
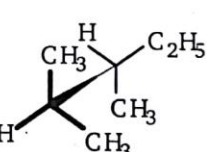
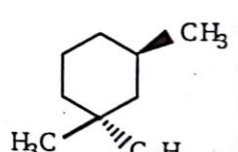
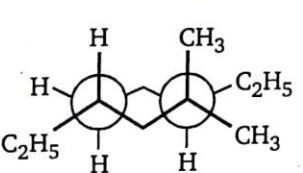
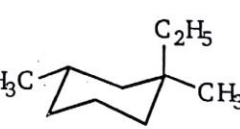
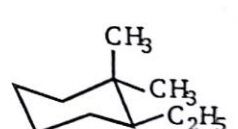
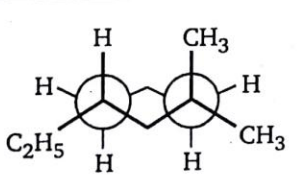
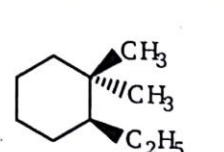
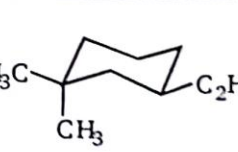
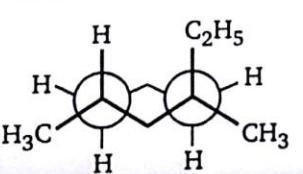
(P) (Q) (R)

(S) (T) (U)

Consider the given structures and answer A, B & C.

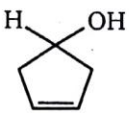
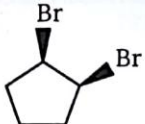
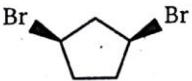
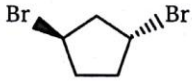
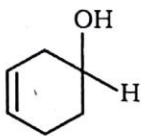
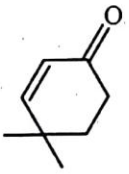
A. Which of the compound is optically active ?

(a) *P* (b) *R* (c) *S* (d) *T*

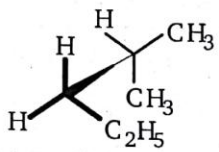
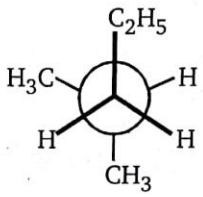
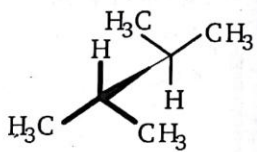
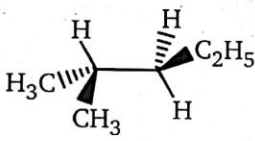
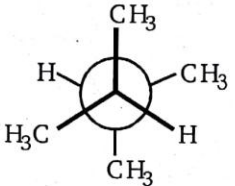
B. Which of the isomer is most stable ?

(a) *R* (b) *S* (c) *T* (d) *U*

19. Identify relationship between following pairs :

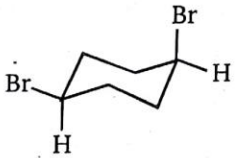
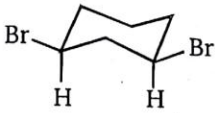
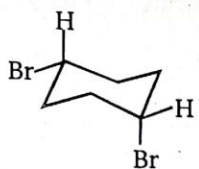
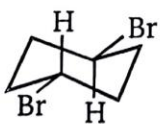
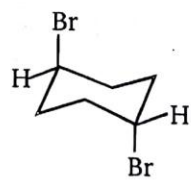
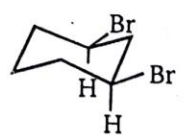
(a)		**(b)**	
(c)		**(d)**	

If they are enantiomer answer will be 1, if they are diastereomers answer will be 2, if they are constitutional isomers answer will be 3 and if they are identical present 4 as the answer. Sum of answer of each part $a + b + c + d$ is : ....

20. In each of the following three questions a hydrocarbon is named. For each select from among the sixteen conformational structures (a through p) all structures that represent possible conformers of that compound. Write letters (a through p), corresponding to your selections, in each answer box.

A.	2-methylbutane	
B.	2,3-dimethylpentane	
C.	1-ethyl-1, 3-dimethyl cyclohexane	

(a)	H, CH_3, CH_3, CH_3, C_2H_5, H	**(b)**	H, CH_3, CH_3, H, H_3C, H	**(c)**	H, H_3C, H, H_3C, C_2H_5, CH_3
(d)	H, H, CH_3, H_3C, H, CH_3	**(e)**	CH_3, H, H, H, CH_3, CH_3	**(f)**	H, CH_3, H, C_2H_5, H_3C, CH_3
(g)	CH_3, H, H, H_3C, C_2H_5, CH_3	**(h)**	H, C_2H_5, CH_3, CH_3, H, CH_3	**(i)**	CH_3, H_3C, C_2H_5
(j)	H, CH_3, H, C_2H_5, C_2H_5, CH_3, H, H	**(k)**	C_2H_5, H_3C, CH_3	**(l)**	CH_3, CH_3, C_2H_5
(m)	H, CH_3, H, H, C_2H_5, CH_3, H, H	**(n)**	CH_3, CH_3, C_2H_5	**(o)**	H_3C, C_2H_5, CH_3
(p)	H, C_2H_5, H, H, H_3C, CH_3, H, H				

21. Examine structures a through j, shown below, with respect to their symmetry or lack of it. Assume that the five-membered rings and the ring in compound g are planar. The wedge-hatched bonds in b, c, d & e designate specific configurations. Also, for the acyclic compounds assume stable anti conformations. Answer each of the following questions by writing letters (a through j), corresponding to your selections, in each answer box. If there is no structure that fits the description enter an x in the answer box.

A.	Which structures are chiral ?	
B.	Which structures have a plane of symmetry ?	
C.	Which structures have a center of symmetry ?	

(a)	H, OH	**(b)**	Br, Cl	**(c)**	Br, Br
(d)	Br, Br	**(e)**	Br, Br	**(f)**	OH, H
(g)	O	**(h)**	$C_2H_5CHCl_2$	**(i)**	$C_2H_5CHClC_2H_5$
(j)	$C_2H_5CHClCH_3$				

22. **(i) 1,2-dichlorocyclopropane** = w
(ii) 1,3-dimethyl-cyclobutane = x
(iii) 2-bromo-3-chlorobutane = y
(iv) 1,3-dimethyl cyclohexane = z
Calculate total number of stereoisomer of the above compounds.
Sum of $w + x + y + z = ...$

23. Examine the following formulas and select those pairs that satisfy the following conditions :

Be sure to write two letters (and only two) in each answer box, unless you select f. In the second and third parts more than one answer is possible.

(a)		**(b)**		**(c)**	
(d)		**(e)**		**(f)**	No formulas meet the designated condition

A.	Which are identical in all respects?	
B.	Which are conformational isomers?	
C.	Which are constitutional isomers?	

24. Examine the following formulas and select those pairs that satisfy the following conditions :

Be sure to write two letters (and only two) in each answer box. In the second and fourth parts more than one answer is possible.

(a)		**(b)**		**(c)**	
(d)		**(e)**		**(f)**	

A.	Which are identical in all respects?	
B.	Which are configuration isomers?	
C.	Which are conformational isomers?	

25. Consider the following statements regarding the given projection (True or False).

(W)	Fischer projection: top CH_2Cl; H—C—Br; Cl—C—H; bottom CH_3	**(X)**	Fischer projection: top CH_2Cl; Cl—C—H; H—C—Cl; bottom CH_3
(Y)	Sawhorse: CH_3, H, Cl; H, Br, CH_2Cl	**(Z)**	Newman projection: CH_2Cl, H, Cl; H, Cl, CH_3

(a)	W and Y are diastereomers	
(b)	Z is the projection of X	
(c)	W, X, Y and Z are optically active	
(d)	Y and Z are isomer	

26. Examine the following structural formulas and select those that are chiral.

(a)	Cyclohexane with OH and CN on the same carbon	**(b)**	$(CH_3)_2CH-CH_2-CH(NH_2)-CO_2H$	**(c)**	O= cyclohexanone with gem-dimethyl
(d)	Skeletal structure with OH	**(e)**	Fischer projection: top CO_2H; H—C—OH; H—C—OH; bottom CH_2-CO_2H	**(f)**	Fischer projection: top CN; H—C—OH; HO—C—CH_3; bottom CH_2-CO_2H
(g)	Benzene ring–CH(OH)–CH_3	**(h)**	Biphenyl with SO_3H, NO_2 on one ring and NO_2, SO_3H on the other	**(i)**	$CH_3(H)C=C=C(H)CH_3$
(j)	Fischer projection: top CH_3; H—C—Cl; H—C—Cl; bottom CH_3				
Write your choice here					

27. The configuration of eight compounds, a through h are shown below, using various kind of stereo representations. To answer the question given below, write (a through h) indicating your choice.

A.	Which of these configuration are achiral?	
B.	Which configuration has no stereogenic center?	
C.	Which configuration has more than one stereogenic center?	
D.	Which of these configuration are meso compound?	

28. The structural formula of ten compounds, (I) through (X) are drawn below, you may select any one of these structure.

Answer the following question about that compound.

I	CH_3, CH_3	II	CH_3, CH_3	III	HO, CH_3
IV	CH_3, CH_3	V	CH_3, Et	VI	CH_3, CH_3
VII	CH_3, OH	VIII	OH, CH_3, CH_3, OH	IX	OH, CH_3, CH_3, OH
X	OH, CH_3, CH_3, OH				

A. How many chiral centre are present in this compound ?

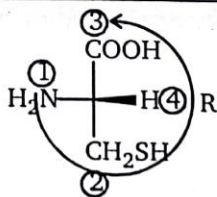
(a) 0 (b) 1 (c) 2 (d) 3
(e) 4 (f) 5

B. Is this compound chiral or achiral ?

(a) Chiral (b) Achiral

C. What symmetry element are present in this compound ?

(a) None (b) Plane of symmetry (c) Center of symmetry

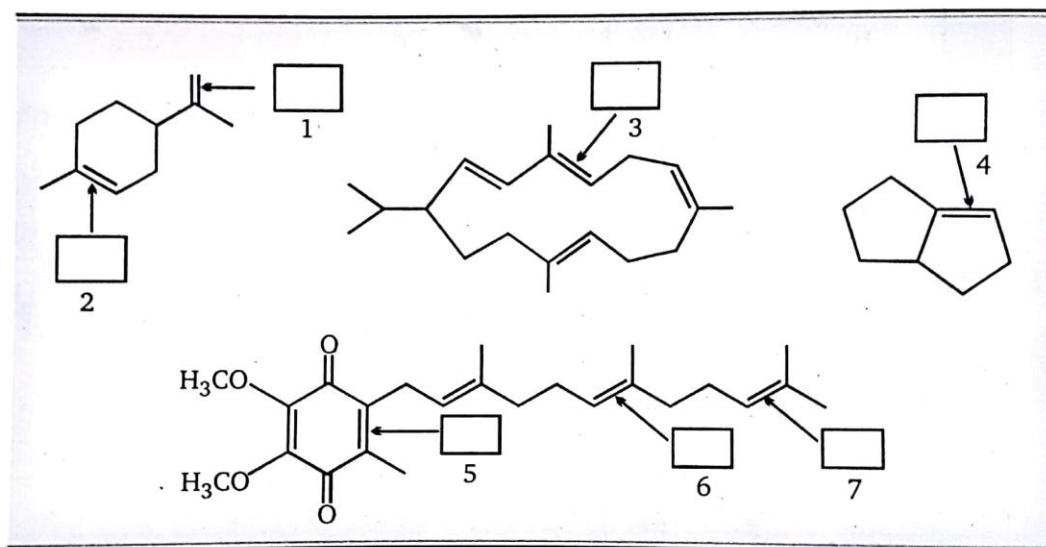
29. The structure of one of the enantiomers of the amino acid cysteine is shown below.

Classify this structure as :

(a) R or S (b) D or L

30. Identify the following double bonds either E, Z or None (N) in the compounds given below either.

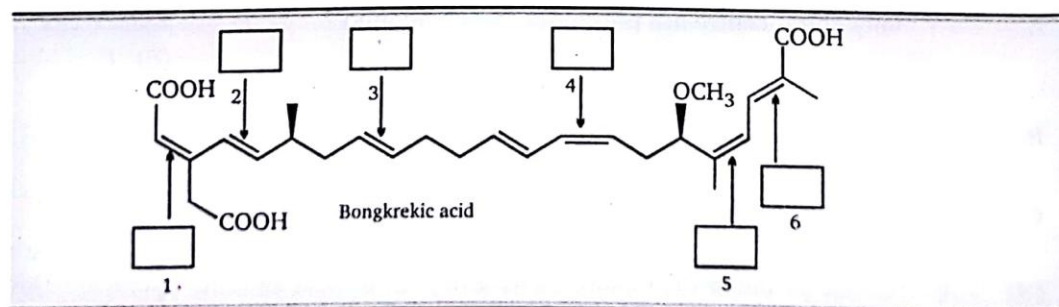
A.

1 2 3 4

H_3CO H_3CO O O 5 6 7

B. (a) Bongkrekic acid is a toxic compound produced by Pseudomonas cocovenenans, and isolated from a mold that rows on bongkrek, a fermented Indonesian coconut dish. (a) Label each double bond as E, Z or neither (N).

COOH 2 3 4 OCH_3 COOH

COOH Bongkrekic acid

1 5 6

(b) How many total stereoisomers (including all types) are possible for bongkrekic acid ?

....

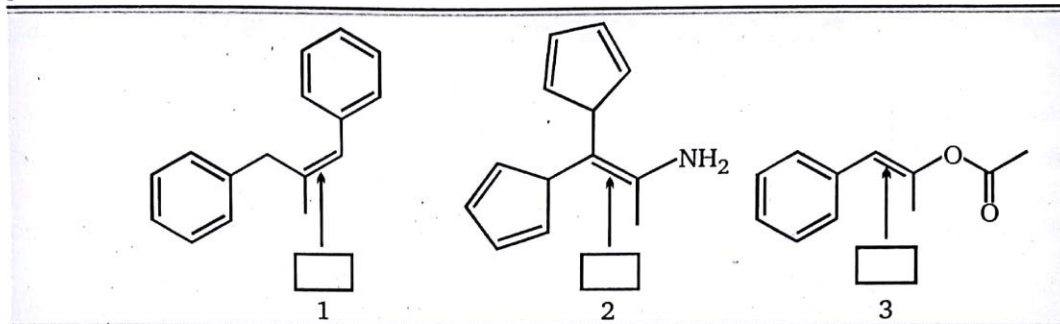
(c) How many sites of unsaturation are present in bongkrekic acid ? ....

31. Designate the following double bonds as E, Z or none (N) configuration in the boxes provided below.

NH_2

O

O

1 2 3

32. The following compounds may exist as two or more stereoisomers. These may be classified as enantiomer pairs or meso compounds.

(a) C_6H_5 CO_2H C_6H_5 CO_2H

truxinic acid

(b) C_6H_5 CO_2H HO_2C C_6H_5

truxillic acid

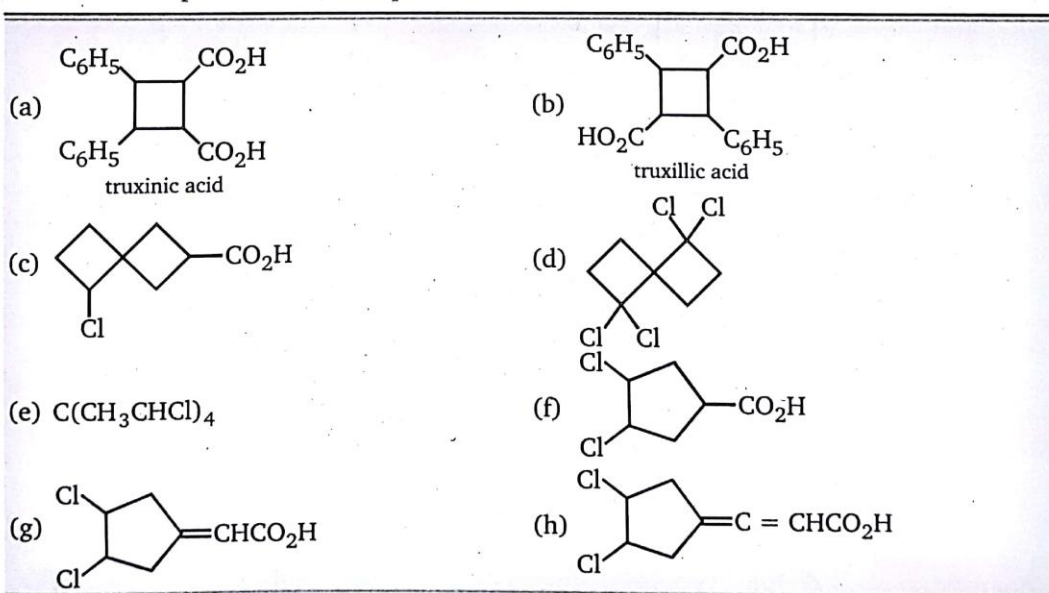
(c) CO_2H Cl

(d) Cl Cl Cl Cl

(e) $C(CH_3CHCl)_4$

(f) Cl CO_2H Cl

(g) Cl $=CHCO_2H$ Cl

(h) Cl $=C = CHCO_2H$ Cl

Answer the following question about the above structure.

(A) Total number of stereoisomers :

(B) Number of enantiomeric pairs :

(C) Number of meso compounds :

33. Identify axis of symmetry in the given compound.

(1) Me Cl Cl Me Me Cl Cl Me

(2) Et Et Et Et Et Et

(3) Me N O O O Me N O O O O O N Me

(4) Cl Cl Cl

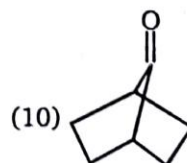
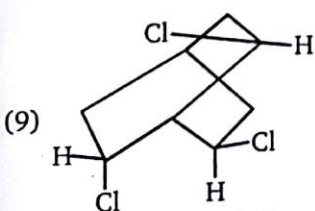
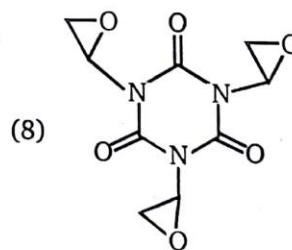
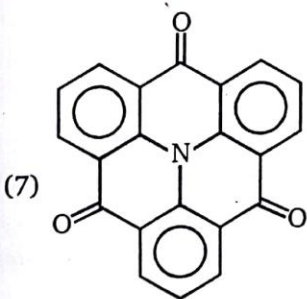
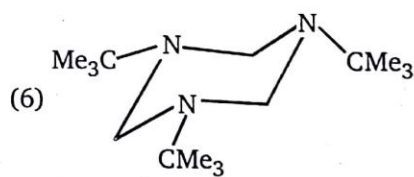
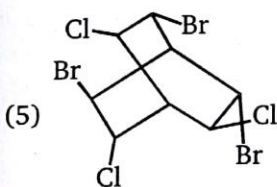
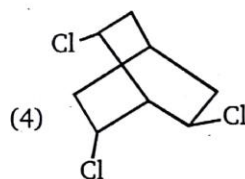
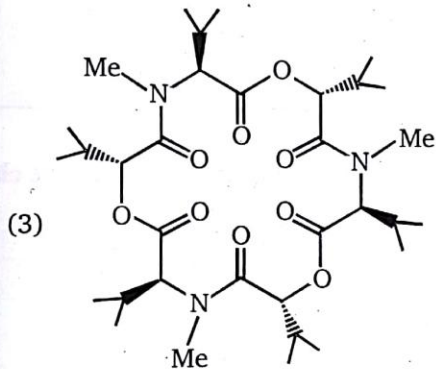
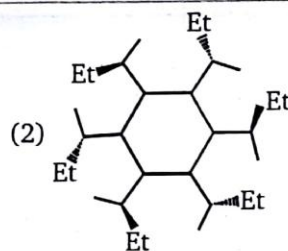
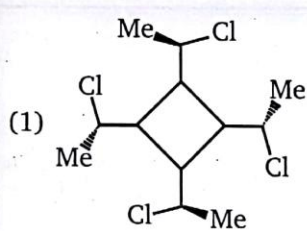
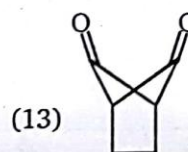
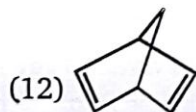
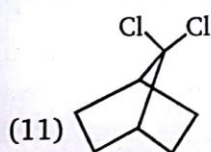
(5) Cl Br Br Cl Br Cl

(6) Me_3C N N CMe_3 N CMe_3

(7) O N O O

(8) O O O N N O N O O

(9) Cl H H Cl Cl H

(10) O

34. For each of the following pharmaceutical compounds, identify all stereogenic (*i.e.*, all asymmetric carbon atoms) and label the configuration of each as being either (R) or (S).

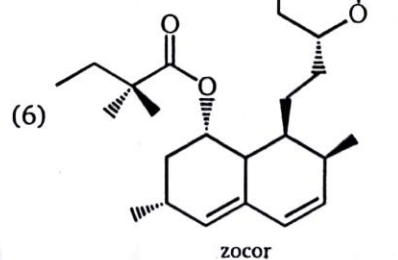
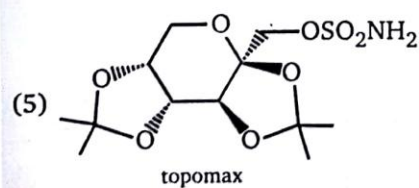
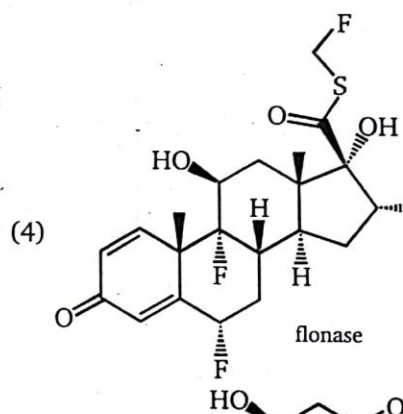
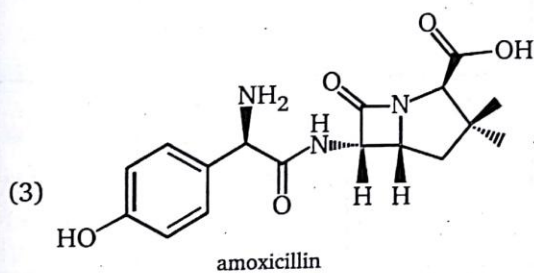
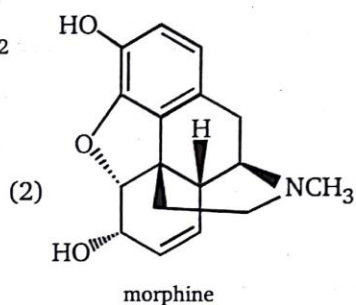
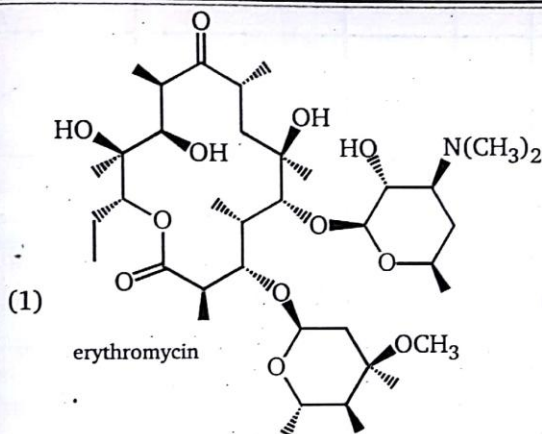
(1) erythromycin

(2) morphine

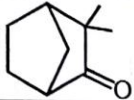
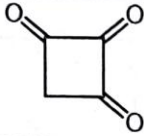
(3) amoxicillin

(4) flonase

(5) topomax

(6) zocor

35. Find relationship between given pair :

		Identical	Enantiomer	Diastereomer	Constitutional Isomer
1.	CO_2H CO_2H				
2.					
3.	OH OH OH OH				
4.	CH_3, H–OH, H–OH, Et; Et, HO–H, HO–H, CH_3				
5.	H, CH_3, CH_3, H; CH_3, H, H, CH_3				
6.	CH_3 CH_3 H H C H CH_3; CH_3 CH_3 H H C CH_3 H				
7.					

36. Comprehension

Structural formula of compound (A) is following:

HO_2C — cyclopentane — CO_2H

A. The correct statement(s) about the compound (A) is/are:

(a) The total number of stereoisomers possible for (A) is 3

(b) The total number of mesoisomer possible for (A) is 1

(c) The total number of pair of enantiomer possible for (A) is 1

(d) All of these

B. Number of plane of symmetry in *cis*-form of compound (A) is:

(a) 0 (b) 1 (c) 2 (d) 3

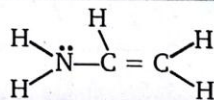
37. Match the column. **(Matrix)**

	Column (I)		**Column (II)**
	No. of Carbon		**No. of structural isomer**
(a)	C_4H_{10}	**(p)**	2
(b)	C_5H_{12}	**(q)**	3
(c)	C_6H_{14}	**(r)**	5
(d)	C_7H_{16}	**(s)**	9

38. Match the column. **(Matrix)**

	Column (I) Compound		Column (II) % of enol content
(a)		**(p)**	100 %
(b)		**(q)**	76 %
(c)	$CH_3-\overset{O}{\overset{\parallel}{C}}-CH_2-\overset{O}{\overset{\parallel}{C}}-CH_3$	**(r)**	8%
(d)	$CH_3-\overset{O}{\overset{\parallel}{C}}-CH_2-\overset{O}{\overset{\parallel}{C}}-O-Et$	**(s)**	Keto-Enol is not possible

39. Draw a most stable conformation (N – C) bond in the following compound.

$H_2\ddot{N}-CH=CH_2$

40. Find total number of stereoisomers for each compound given below :

(1) $Ph-\overset{O}{\overset{\parallel}{S}}-CH=CH-CH_2-CH=C=C=CH-CH=CH-CH_3$

(2)

(3)

(4) $Ph-\underset{OH}{\underset{|}{CH}}-\underset{CH_3}{\underset{|}{CH}}-NH-CH_3$

(5)

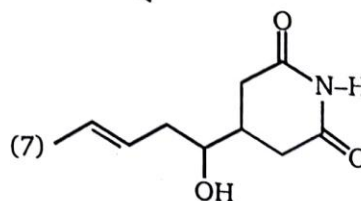
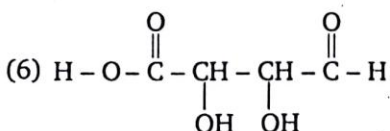
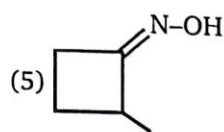
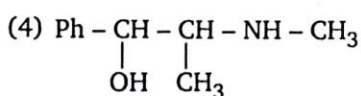
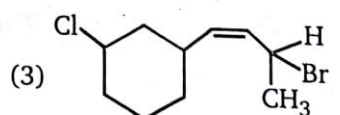
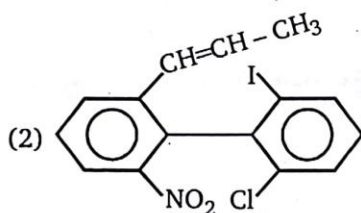
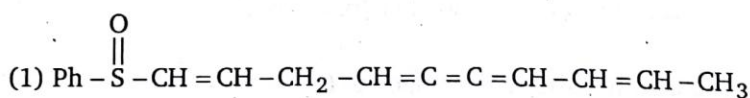
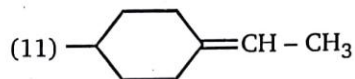
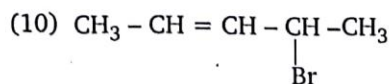
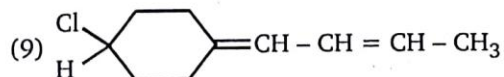
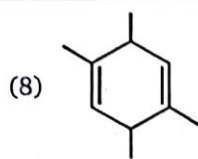
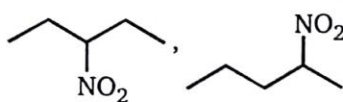
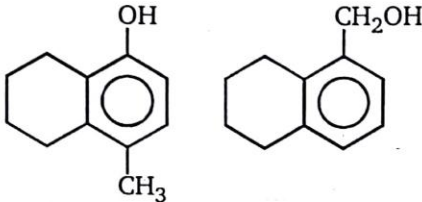
(6) $H-O-\overset{O}{\overset{\parallel}{C}}-\underset{OH}{\underset{|}{CH}}-\underset{OH}{\underset{|}{CH}}-\overset{O}{\overset{\parallel}{C}}-H$

(7)

(8)

(9) Cl, H > cyclohexylidene =CH – CH = CH – CH_3

(10) $CH_3 - CH = CH - \underset{\underset{Br}{|}}{CH} - CH_3$

(11) – cyclohexylidene =CH – CH_3

41. Find the total number of stereoisomer for each compound :

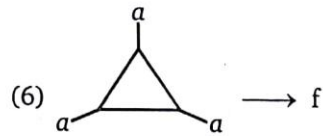
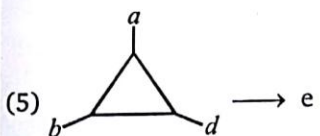
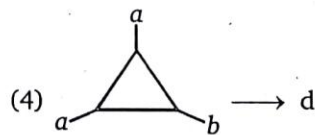
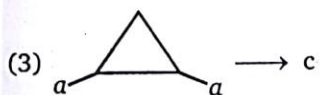
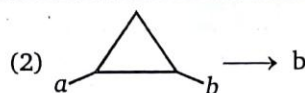
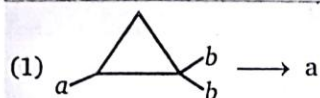
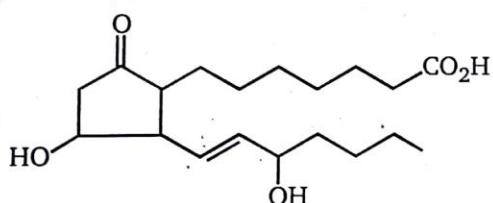
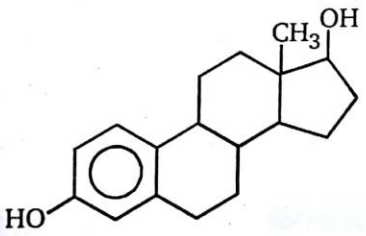
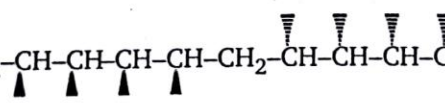
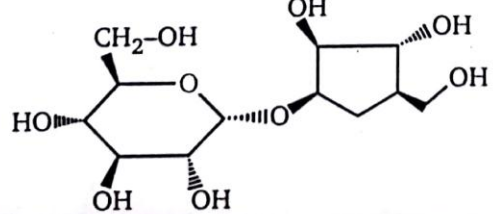
(1) ⟶ a

(2) ⟶ b

(3) ⟶ c

(4) ⟶ d

(5) ⟶ e

(6) ⟶ f

42. Match the column :

	Column (I) Pair		Column (II) Isomeric Relationship
(a)	$C_6H_5-\overset{O}{\overset{\|\|}{C}}-O-C_6H_4-CH_3$; $CH_3-C_6H_4-\overset{O}{\overset{\|\|}{C}}-O-C_6H_5$	**(p)**	Chain
(b)	$CH_3-CH_2-CH_2-\overset{O}{\overset{\|\|}{C}}-OH$, $CH_3-\underset{\underset{CO_2H}{\|}}{CH}-CH_3$	**(q)**	Positional

(c)	NO_2 , NO_2	**(r)**	Functional
(d)	OH, CH_3 ; CH_2OH	**(s)**	Metamers

43. Find sum of stereoisomer of following compound.

		Number of stereoisomers
(a)	O, CO_2H, HO, OH →	(*a*)
(b)	CH_3, OH, HO →	(*b*)
(c)	$HOCH_2–CH–CH–CH–CH–CH_2–CH–CH–CH–CH–CH_2–OH$ →	(*c*)
(d)	$CH_2–OH$, O, HO, OH, OH, O, OH, OH, OH →	(*d*)

44.

1 Prostaglandin E_1

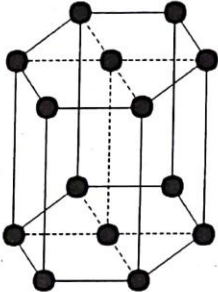
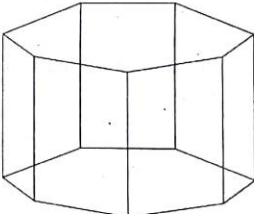
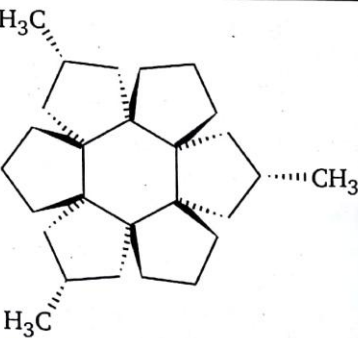
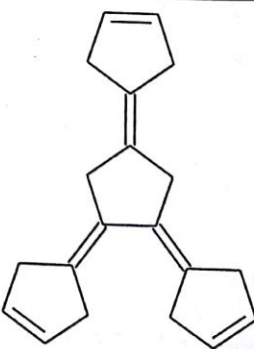
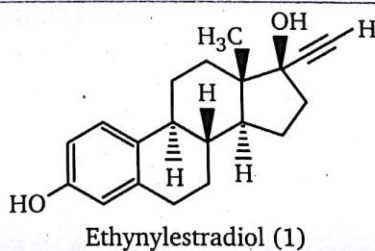
Prostaglandin E_1 1 is a compound produced by the body to regulate a variety of processes including blood clotting, fever, pain and inflammation.

A. Which of the following functional groups is not contained in 1 ?
(a) A ketone (b) An alcohol (c) A carboxylic acid (d) An alkene
(e) A nitrile

B. How many asymmetric (stereogenic) centres are present in compound 1?
(a) 3 (b) 4 (c) 5 (d) 6

C. How many sp^2 hybridised carbon atoms are present in compound 1 ?
(a) 1 (b) 2 (c) 3 (d) 4

D. What is the geometric configuration about the double bond in compound 1?
(a) *E* (b) *Z*

45.

Ethynylestradiol (1)

The synthetic steroid ethynylestradiol (1) is a compound used in the birth control pill.

A. How many sp^3 hybridised carbon atoms are present in compound (1)?
(a) 8 (b) 9 (c) 10 (d) 11 (e) 12

B. How many sp^2 hybridised carbon atoms are present in compound (1) ?
(a) 4 (b) 5 (c) 6 (d) 7 (e) 8

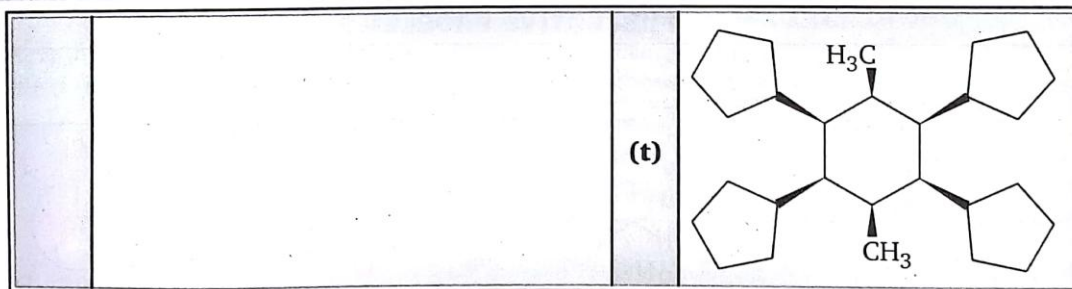
C. How many *sp* hybridised carbon atoms are present in compound (1) ?
(a) 2 (b) 4 (c) 6 (d) 8 (e) 10

D. Which of the following functional group is contained in compound (1) ?
(a) A ketone (b) An alcohol (c) A carboxylic acid (d) An ester

E. How many asymmetric (stereogenic) centres are present in compound (1) ?
(a) 2 (b) 3 (c) 4 (d) 5

46. Match the column.

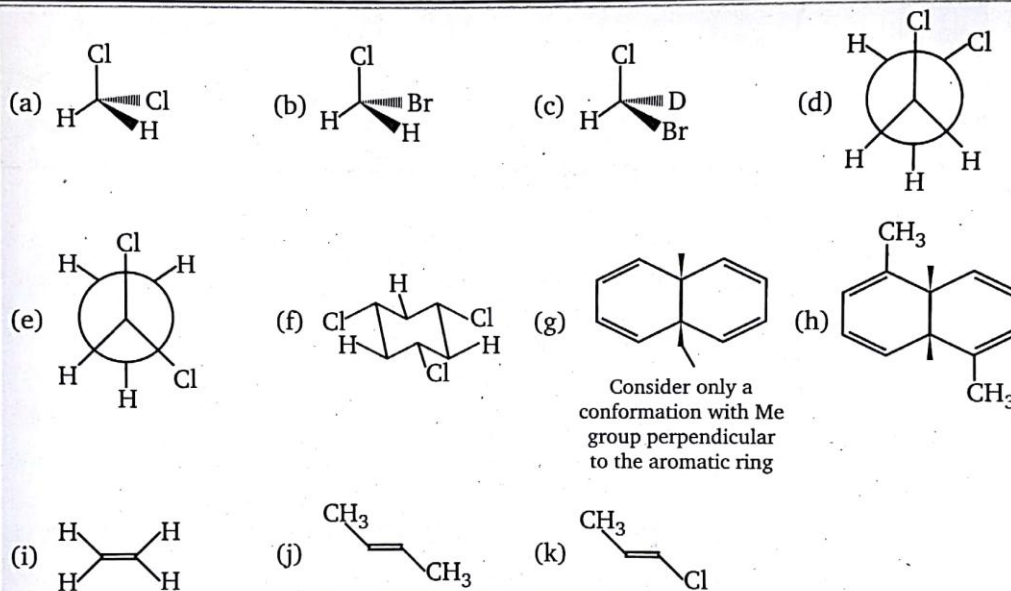
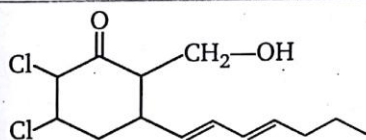
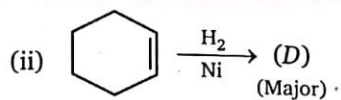
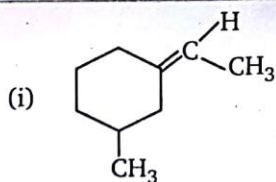
	Column (I)		Column (II)
(a)	C_2-axis of symmetry	**(p)**	
(b)	C_3-axis of symmetry	**(q)**	
(c)	Plane of symmetry	**(r)**	H_3C CH_3 H_3C
(d)	Centre of symmetry	**(s)**	

(t)
H_3C
CH_3

SUBJECTIVE PROBLEMS

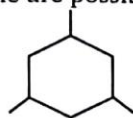
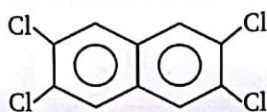
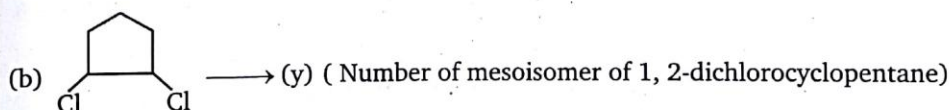
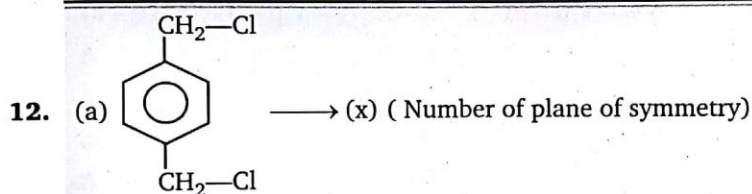
1. Number of chiral isomers are:

2. Cl, Cl, O, CH_2—OH

Number of stereoisomer are

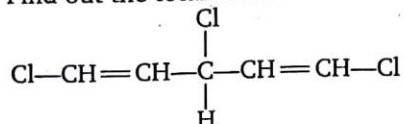
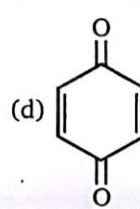
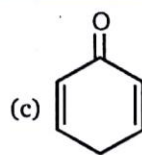
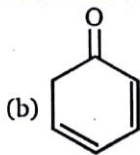
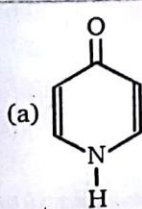
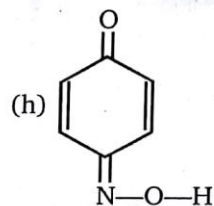
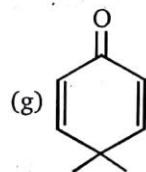
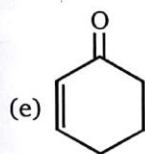
3. (i) H, C, CH_3, CH_3 (C) (ii) $\xrightarrow[Ni]{H_2}$ (D) (Major)

Sum of number of stereoisomer (C) Degree of unsaturations in (D).

4. How many 5 membered parent chain alkane are possible for C_7H_{16}?

5. Theoretical possible geometrical isomer of

6. Total number of possible structural isomers of $C_5H_{11}Br$.
7. Total number of plane of symmetry present in given compound is

8. Total number of isomers for $C_4H_6Br_2$ containing cyclobutane ring are (including stereoisomer) ?
9. Total number of structural isomers of C_9H_{18} containing cyclohexane ring.
10. How many structural isomer are possible for $C_4H_{10}O$ (only alcohol).
11. Number of structural isomer of C_6H_{14} is .

13. Find out the total number of stereocentre in the given compound.

$CH_3—CH{=}CH—CH(Br)—CH(Cl)—CH_3$

14. Find out the total number of stereoisomers of the given following compound.

$Cl—CH{=}CH—C(Cl)(H)—CH{=}CH—Cl$

15. Find the total number of isomers of C_7H_{14} (only 5-membered ring).
16. x =number of compounds which undergoes Tautomerisation to form an Aromatic product.

17. If molecule is pyramidal, **X** stereoisomers are possible for :

$$\mathbf{C_{abed}}$$

find the value of **X**.

ANSWERS — LEVEL 2

1. a – q; b – p; c – r; d – s
2. a – s; b – r; c – q; d – p
3. a – p, s; b – q, r, s; c – q, r, s; d – p, s
4. a – p, q; b – p, q; c – p, q; d – p, r
5. a – r; b – r; c – p; d – s
6. a – p, r; b – q, s; c – q, r; d – p, s
7. a – q, r; b – q, s; c – p, q, r; d – q, s
8. a – r, s; b – p, q; c – r, s; d – p, r, s
9. a – q; b – q, s; c – p, q, s; d – q, s
10. a – p; b – q; c – s; d – r
11. a – p; b – q; c – r; d – s
12. a – q, r; b – p; c – p; d – q, r
13. a – r; b – s; c – r; d –p
14. a – s; b – r; c – q; d – p
15. a – q, r; b – r, s; c – q, r; d – p, q
16. (a – p – x); (b – q, r – y); (c – p – x); (d – q, r – w)
17. A – b,h; B – a, g; C – c, e; D – d, f
18. A – d; B – a
19. $a + b + c + d = 13$
20. A – b, d, e; B – a, c, f, h; C – i, k, p
21. A – e, f, j; B – a, c, d, g, h, i, b; C – None
22. $w + x + y + z = 12$
23. A – (c & e), (b & d); B – (a & b) or (a & d); C – (a & c) or (a & e), (b & c), (b & e), (c & d) and (d & e)
24. A – (a & c) (b & f); B – (a & d) or (c & d), (a & e) (c & d); C – (d & e)
25. a – True; b – True; c – True; d – False
26. b, e, f, g, h, i
27. A – d, h; B – d; C – f, h; D – h
28.

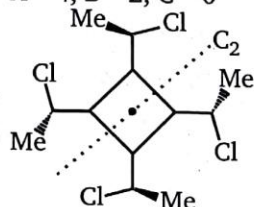
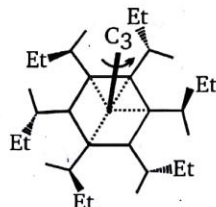
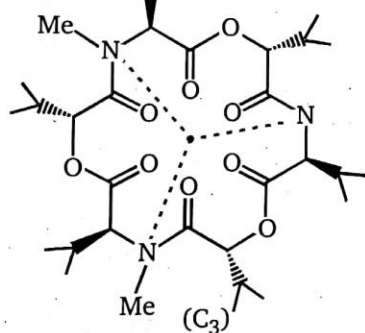
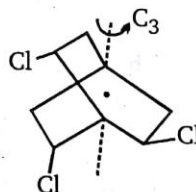
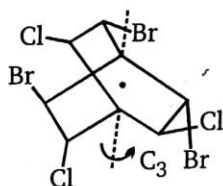
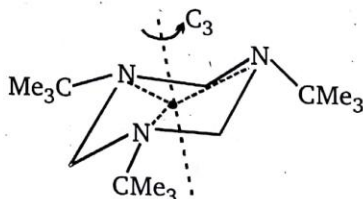
Compound	A	B	C
I	c	a	a
II	c	b	b
III	c	a	a
IV	c	b	b
V	c	a	a
VI	c	a	a
VII	c	a	a
VIII	e	b	b
IX	e	a	a
X	e	b	b

29. (a) Ⓡ (b) Ⓛ

30A. 1 – N; 2 – Z; 3 – E; 4 – Z; 5 – Z; 6 – E; 7 – N

B. (a) 1 – Z; 2 – E; 3 – E; 4 – Z; 5 – Z; 6 – E (b) 2^9 (c) 10

31. 1 – Z; 2 – N; 3 – E

32. (a) A – 10, B – 4, C – 2 (b) A – 5, B – 0, C – 5
(c) A – 4, B – 2, C – 0 (d) A – 2, B – 1, C – 0
(e) A – 5, B – 2, C – 1 (f) A – 4, B – 1, C – 2
(g) A – 4, B – 2, C – 0 (h) A – 4, B – 1, C – 2

33. (1) (2)

(3) (4)

(5)

(6)

(7) C_3 axis, C_2 axis (8) C_3-axis

(9) C_3 axis (10)

(11) (12) C_2-axis (13) C_2-axis

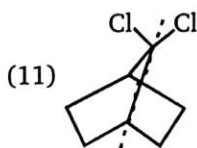
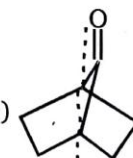
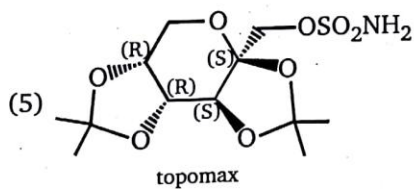
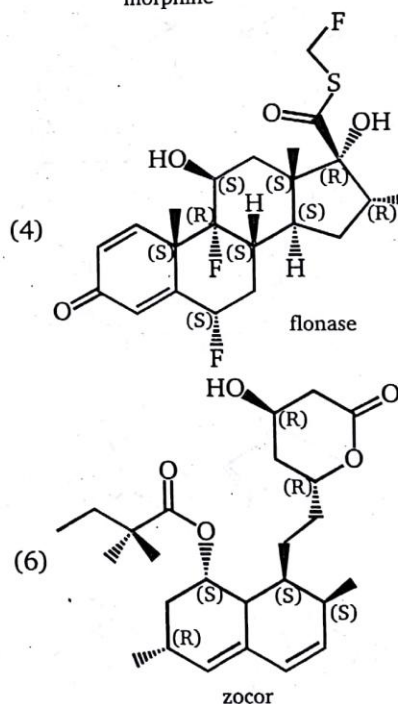
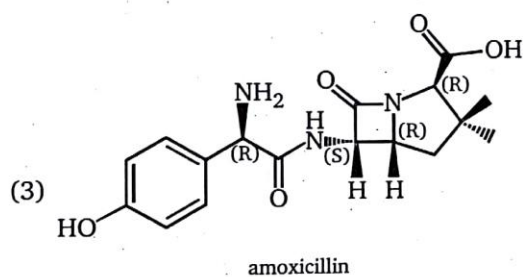
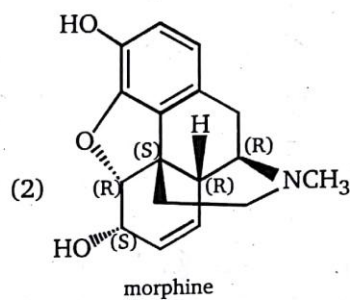
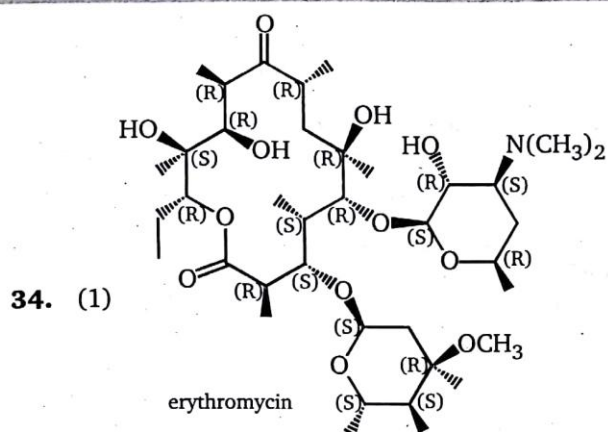
34. (1) erythromycin

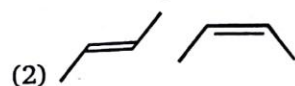
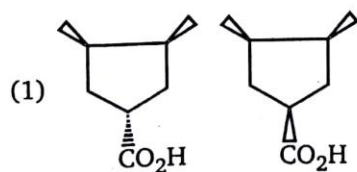
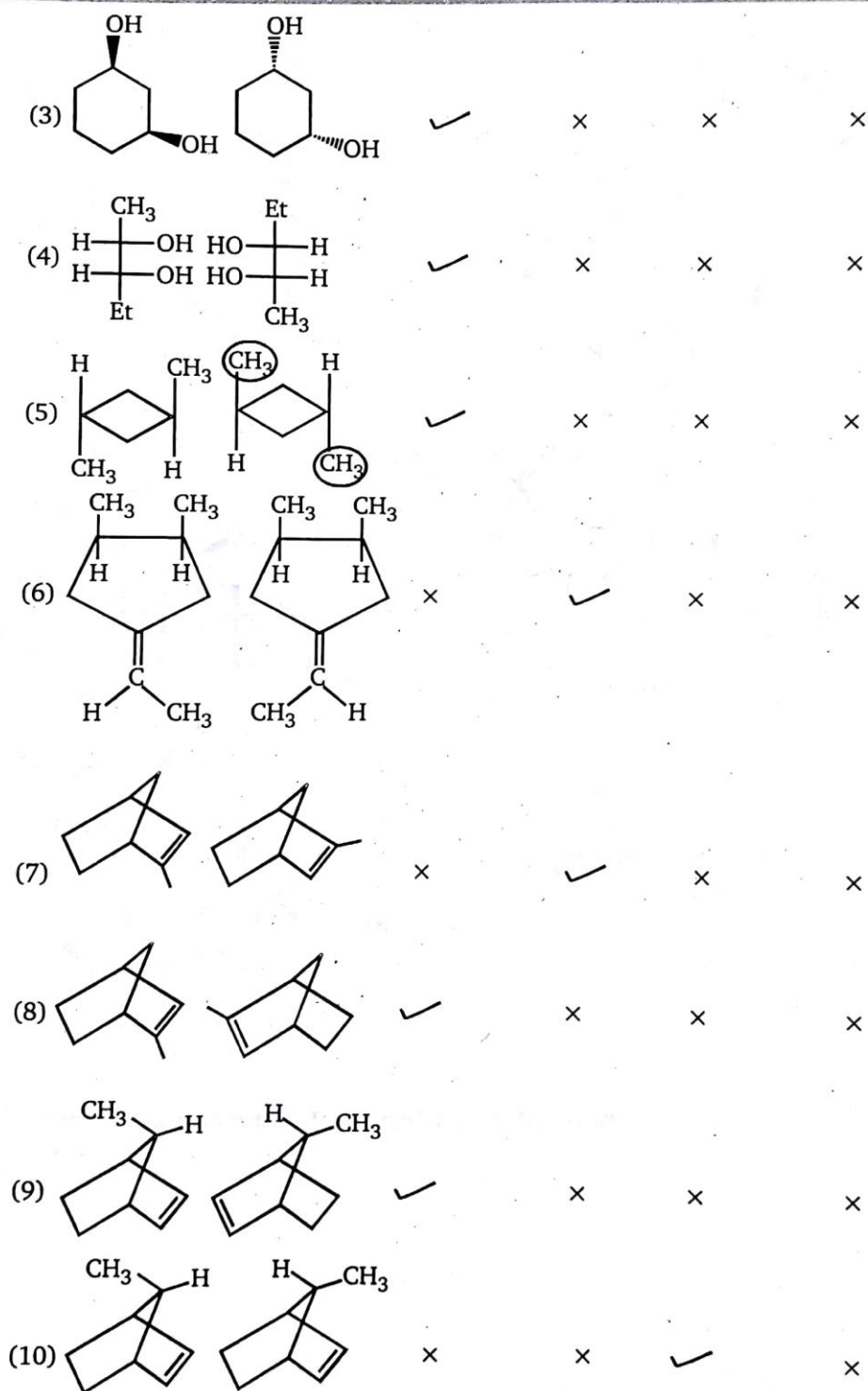
(2) morphine

(3) amoxicillin

(4) flonase

(5) topomax

(6) zocor

35.

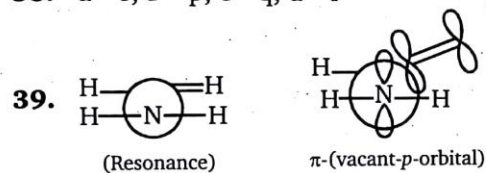
	Identical	Enantiomer	Diastereomer	Constitutional Isomer
(1) CO_2H CO_2H	×	×	✓	×
(2)	×	×	✓	×

36. (A) - (d) (B) - (b)

37. a – p; b – q; c – r; d – s

38. a – s; b – p; c – q; d – r

39.

(Resonance)

π-(vacant-*p*-orbital)

40. (1) 16 (2) 4 (3) 16 (4) 4 (5) 4
(6) 4 (7) 4 (8) 3 (9) 4 (10) 4
(11) 2

41. a – 2, b – 4, c – 3, d – 4, e – 8, f – 2

42. a – s; b – p; c – q; d – r

43. a – 2^5, b – 2^5, c – $2^7 + 2^3$, d – 2^9

44. A – e; B – b; C – d; D – a

45. A – e; B – c; C – a; D – b; E – d

46. a – p, q, s, t; b – p, r; c – p, q, r, s, t; d – p

Subjective Problems

1. 3 (c, f, h) **2.** 64 **3.** 5 **4.** 5 **5.** 2 **6.** 8. **7.** 3
8. 6 **9.** 12 **10.** 4 **11.** 5 **12.** 4 **13.** 4 **14.** 4 **15.** 8
16. 4 (a, b, c, h) **17.** 6

3 GRIGNARD REAGENT

LEVEL- 1

1. What is the major product of the following reaction ?

[Reaction: cyclohexane fused oxetane $\xrightarrow[Et_2O]{CH_3MgI}$ $\xrightarrow{H_3O^{\oplus}}$]

(a) cyclohexane with CH_3 and CH_2-OH on adjacent carbons

(b) cyclohexane with OH and CH_2-CH_3 on adjacent carbons

(c) cyclohexane with $O-CH_3$ and CH_3 on adjacent carbons

(d) cyclohexane with OH and CH_3 on adjacent carbons

2. [Cyclohexane bearing CH_3 and $\underset{\underset{O}{\|}}{C}-OCH_3$ on one carbon, and $CH_2-\underset{\underset{O}{\|}}{C}OCH_3$ on the adjacent carbon] $\xrightarrow[(1\ equivalent)]{PhMgBr}$ (P). Product (P) is :

(a) Cyclohexane ring bearing CH_3 and $-\overset{O}{\overset{\|}{C}}-Ph$ on one carbon, and $CH_2-\underset{O}{\underset{\|}{C}}OCH_3$ on the adjacent carbon

(b) Cyclohexane ring bearing CH_3 and $-\overset{O}{\overset{\|}{C}}-Ph$ on one carbon, and $CH_2-\underset{O}{\underset{\|}{C}}OCH_3$ on the adjacent carbon

(c) Cyclohexane ring bearing CH_3 and $-\underset{O}{\underset{\|}{C}}-Ph$ on one carbon, and CH_3 and $CH_2-\underset{O}{\underset{\|}{C}}OCH_3$ on the adjacent carbon

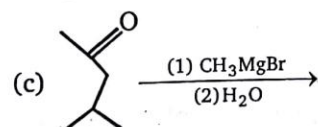
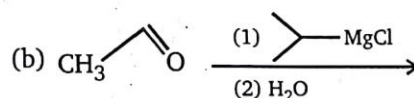
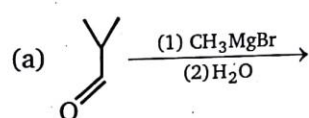
(d) Cyclohexane ring bearing CH_3 and $-\underset{O}{\underset{\|}{C}}-OCH_3$ on one carbon, and $CH_2-\underset{O}{\underset{\|}{C}}-Ph$ on the adjacent carbon

3. Reaction- 1 ; HO–CH_2–CH(SH)–C_6H_3(COCl)(COCl) $\xrightarrow[\text{2. } H_3O^{\oplus}]{\text{1. x } CH_3MgBr}$ HO–CH_2–CH(SH)–C_6H_3[C(OH)(CH_3)$_2$][C(OH)(CH_3)$_2$]

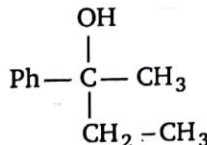
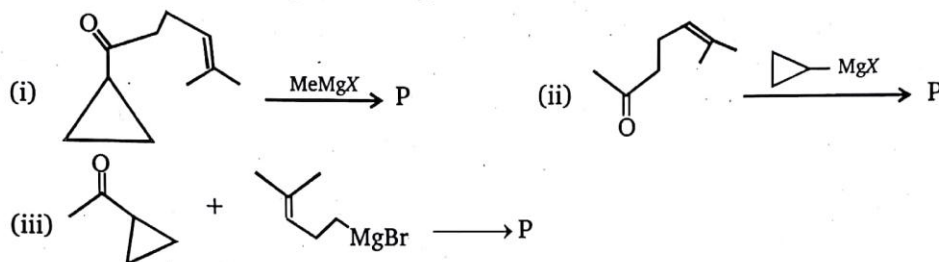
Reaction- 2 ; p-($ClCH_2$)C_6H_4–$\overset{O}{\overset{\|}{C}}$–O–Et $\xrightarrow[\text{2. } H_3O^{\oplus}]{\text{1. y } CH_3MgBr}$ p-($ClCH_2$)C_6H_4–C(OH)(CH_3)$_2$

What is the ratio of (x/y) in above problem ?

(a) 1.5 (b) 2 (c) 2.5 (d) 3

4. In which of the following reaction 2° alcohol is obtained as a product ?

(d) Both (a) and (b)

5. What product would you expect to obtain from Grignard reaction when an excess of phenylmagnesium bromide reacts with dimethyl carbonate $CH_3OCOOCH_3$?

(a) $CH_3-\underset{Ph}{\overset{OH}{C}}-Ph$ (b) $CH_3-\overset{OH}{CH}-Ph$ (c) $Ph-\underset{Ph}{\overset{OH}{C}}-Ph$ (d) $CH_3-\overset{O}{\overset{\|}{C}}-Ph$

6. In which of the following reactions product formed is same ?

(a) (i) and (ii) (b) (ii) and (iii) (c) (i) and (iii) (d) (i), (ii) and (iii)

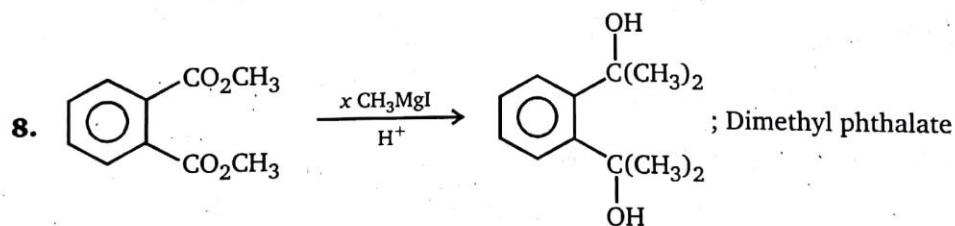
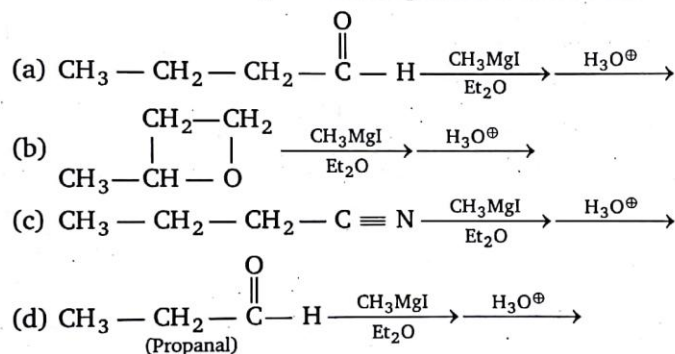
7. Which of the following reaction sequences would be the best for synthesis of 2-pentanone ?

(a) $CH_3-CH_2-CH_2-\overset{O}{\overset{\|}{C}}-H \xrightarrow[Et_2O]{CH_3MgI} \xrightarrow{H_3O^\oplus}$

(b) $\begin{matrix} & CH_2-CH_2 \\ & | \quad\quad | \\ CH_3- & CH-O \end{matrix} \xrightarrow[Et_2O]{CH_3MgI} \xrightarrow{H_3O^\oplus}$

(c) $CH_3-CH_2-CH_2-C\equiv N \xrightarrow[Et_2O]{CH_3MgI} \xrightarrow{H_3O^\oplus}$

(d) $\underset{\text{(Propanal)}}{CH_3-CH_2-\overset{O}{\overset{\|}{C}}-H} \xrightarrow[Et_2O]{CH_3MgI} \xrightarrow{H_3O^\oplus}$

8. $C_6H_4(CO_2CH_3)_2 \xrightarrow[H^+]{x\ CH_3MgI} C_6H_4[C(OH)(CH_3)_2]_2$; Dimethyl phthalate

Number of moles (x) of Grignard reagent consumed in the above reaction is :

(a) 2 (b) 3 (c) 4 (d) 5

9. $Ph-\underset{CH_2-CH_3}{\overset{OH}{C}}-CH_3$

Which of the following combinations can not be used to prepare alcohol given above ?

(a) PhMgBr + 2-butanone $\xrightarrow[NH_4Cl]{}$

(b) EtMgBr + $Ph-\overset{O}{\overset{\|}{C}}-CH_3 \xrightarrow[NH_4Cl]{}$

(c) $CH_3MgBr + Ph-\overset{O}{\overset{\|}{C}}-Et \xrightarrow[NH_4Cl]{}$

(d) EtMgBr + $Ph-\overset{O}{\overset{\|}{C}}-CH_2-CH_3 \xrightarrow[NH_4Cl]{}$

10. $Et-O-\overset{O}{\overset{\|}{C}}-O-Et \xrightarrow[(2)\ H_3O^{\oplus}]{(1)\ CH_3MgBr\ (excess)}$ (*A*), Product (*A*) is :

(a) $CH_3-\overset{O}{\overset{\|}{C}}-O-Et$ (b) $CH_3-\overset{O}{\overset{\|}{C}}-CH_3$

(c) $CH_3-\underset{CH_3}{\underset{|}{\overset{OH}{\overset{|}{C}}}}-CH_3$ (d) $CH_3-CH_2-CH_3$

11. PhMgBr (excess) + (cyclic carbonate, 1,3-dioxan-2-one) $\xrightarrow{H^+}$ (*A*). Product (*A*) is :

(a) $Ph-\overset{O}{\overset{\|}{C}}-Ph$ (b) $Ph-\underset{Ph}{\underset{|}{\overset{OH}{\overset{|}{C}}}}-Ph$ (c) $Ph-\underset{Ph}{\underset{|}{\overset{OH}{\overset{|}{C}}}}$–(butyl chain) (d) $Ph-\overset{O}{\overset{\|}{C}}-O$–(butyl chain)

12. $C_6H_5-\overset{O}{\overset{\|}{C}}-\underset{CH_3}{\underset{|}{N}}OCH_3$ + CH_3MgBr $\xrightarrow[H_2O]{5\%\ HCl}$ (*P*). Product (*P*) is :

N-Methoxy-N-methyl benzamide 1-equivalent; Methyl magnesium bromide 75 equivalent; >90%

(a) $Ph-\underset{Ph}{\underset{|}{\overset{OH}{\overset{|}{C}}}}-Ph$ (b) $Ph-\underset{CH_3}{\underset{|}{\overset{OH}{\overset{|}{C}}}}-CH_3$ (c) $Ph-\overset{O}{\overset{\|}{C}}-CH_3$ (d) $Ph-\overset{O}{\overset{\|}{C}}-Ph$

13. Point out the incorrect synthesis :

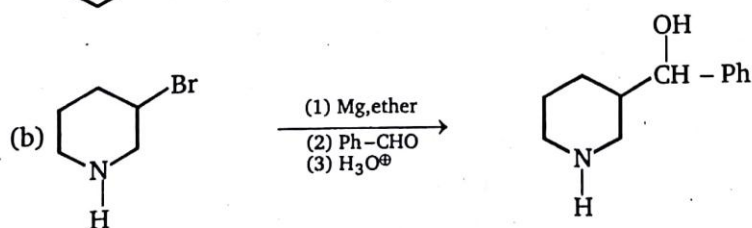
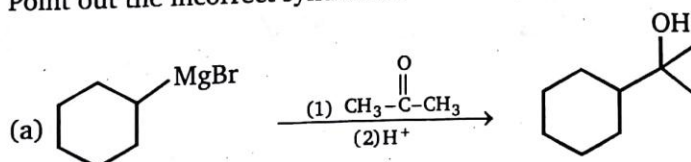
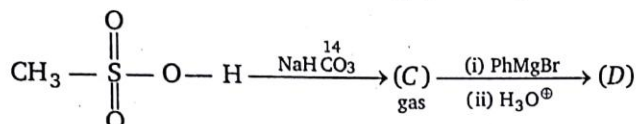
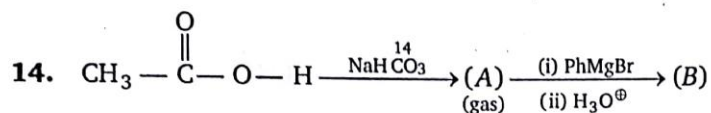
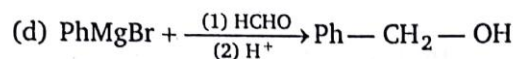
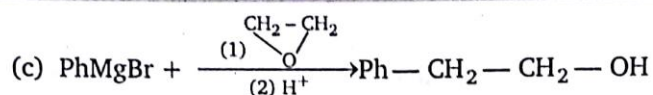
(a) Cyclohexyl–MgBr $\xrightarrow[(2)\ H^+]{(1)\ CH_3-\overset{O}{\overset{\|}{C}}-CH_3}$ Cyclohexyl–C(OH)(CH₃)₂

(b) 3-Bromopiperidine (N–H) $\xrightarrow[(2)\ Ph-CHO\ (3)\ H_3O^{\oplus}]{(1)\ Mg, ether}$ 3-piperidyl–$\overset{OH}{\overset{|}{C}H}-Ph$ (N–H)

(c) PhMgBr + $\xrightarrow[\text{(2) } H^+]{\text{(1) } CH_2-CH_2 \text{ (epoxide, O)}}$ Ph — CH_2 — CH_2 — OH

(d) PhMgBr + $\xrightarrow[\text{(2) } H^+]{\text{(1) HCHO}}$ Ph — CH_2 — OH

14. $CH_3-\overset{O}{\overset{\|}{C}}-O-H \xrightarrow{NaH\overset{14}{C}O_3} \underset{\text{(gas)}}{(A)} \xrightarrow[\text{(ii) } H_3O^{\oplus}]{\text{(i) PhMgBr}} (B)$

$CH_3-\overset{O}{\overset{\|}{\underset{\underset{O}{\|}}{S}}}-O-H \xrightarrow{NaH\overset{14}{C}O_3} \underset{\text{gas}}{(C)} \xrightarrow[\text{(ii) } H_3O^{\oplus}]{\text{(i) PhMgBr}} (D)$

Product (*B*) and (*D*) in the above reaction are :

(a) $Ph-\overset{O}{\overset{\|}{C}}-O-H$, $Ph-\overset{O}{\overset{\|}{\underset{\underset{O}{\|}}{S}}}-O-H$ (b) $Ph-\overset{O}{\overset{\|}{\underset{14}{C}}}-O-H$, $Ph-\overset{O}{\overset{\|}{S}}-O-H$

(c) $Ph-\overset{O}{\overset{\|}{\underset{14}{C}}}-O-H$, $Ph-\overset{O}{\overset{\|}{\underset{14}{C}}}-O-H$ (d) $Ph-\overset{O}{\overset{\|}{C}}-OH$, $Ph-\overset{O}{\overset{\|}{S}}-O-H$

15. (1-ethoxycyclopropanol: cyclopropane with OH and OEt) $\xrightarrow[\text{(2) cyclohexenyl-OLi; (3) } H^+]{\text{(1) MeMgBr, THF 0°C}}$ (*A*); Product (*A*) in this sequence is :

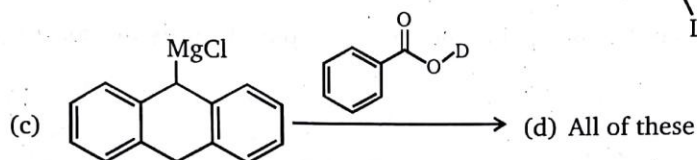
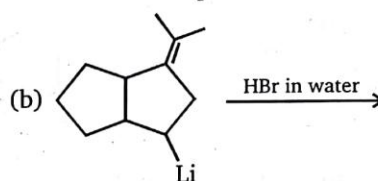
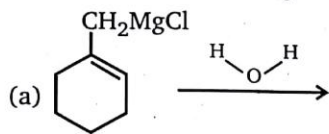
(a) 3-(1-hydroxycyclopropyl)cyclohexanone — OH (b) 2-(1-hydroxycyclopropyl)cyclohexanone — OH (c) cyclohexane-cyclopropane with OH (d) cyclohexyl-cyclopropane with OH

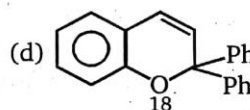
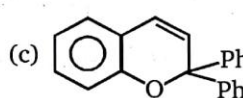
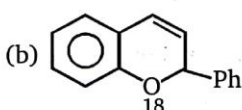
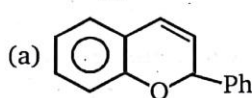
16. (3-methylcyclohexanone, wedge CH_3) $\xrightarrow[\text{diethyl ether}]{CH_3MgBr} \xrightarrow[H_2O]{NH_4Cl}$ Products.

Comment on optical activity of the products. They are ;

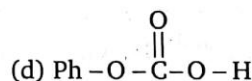
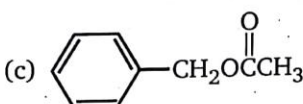
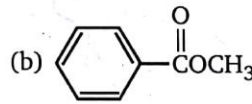
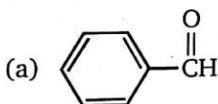
(a) racemic mixture (b) diastereomers

(c) meso forms (d) optically inactive due to absence of chiral centre

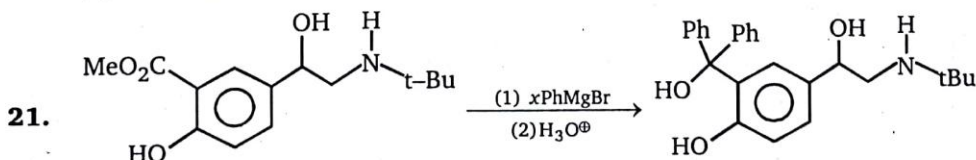
17. In which of the following reaction an acid-base reaction takes place ?

18. $\xrightarrow[(2)\ H_2O]{(1)\ 2PhMgBr} A \xrightarrow[\Delta]{H_2SO_4} (B)$, Product (B) in this reaction is :

(a) Ph (b) Ph, 18 (c) Ph, Ph (d) Ph, Ph, 18

19. All of the following compounds react with ethylmagnesium bromide. Alcohols are formed from three of the compounds. Which one does not give an alcohol ?

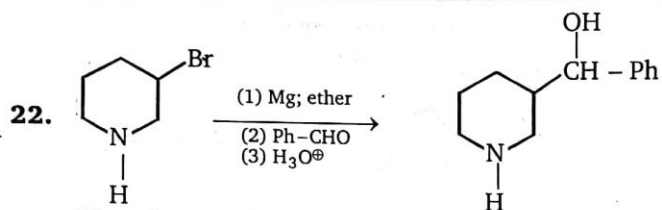
(a) C_6H_5CHO (b) $C_6H_5COOCH_3$

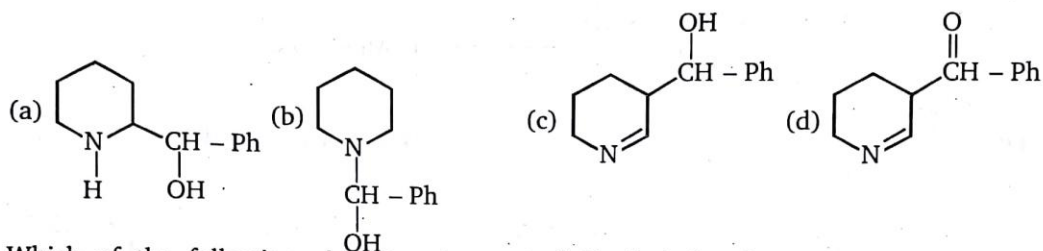
(c) $C_6H_5CH_2OCOCH_3$ (d) Ph – O – C(=O) – O – H

20. A student was carrying out a Grignard reaction between PhMgBr and ethyl benzoate. She ran out of anhydrous ether just after the Grignard reagent was made. Which of the following solvents can still be used to dissolve the ethyl benzoate for its reaction with already formed PhMgBr ?

(a) acetone (b) ethyl acetate (c) absolute alcohol (d) benzene

21.

Number of equivalents of Grignard reagent (x) used in reaction (1) is :

(a) 3 equivalent (b) 4 equivalent (c) 5 equivalent (d) 6 equivalent

22. 3-Bromopiperidine $\xrightarrow[\text{(2) Ph–CHO} \\ \text{(3) } H_3O^{\oplus}]{\text{(1) Mg; ether}}$ 3-(CH(OH)–Ph)piperidine

The given product can not be obtained in the above reaction. Identify the correct product obtained.

(a) 2-(CH(OH)–Ph)piperidine (N–H)
(b) N-(CH(OH)–Ph)piperidine
(c) OH, CH – Ph on a tetrahydropyridine ring (C=N)
(d) O, CH – Ph on a tetrahydropyridine ring (C=N)

23. Which of the following gives two isomers of 3° alcohol, when treated with phenyl magnesium bromide ?

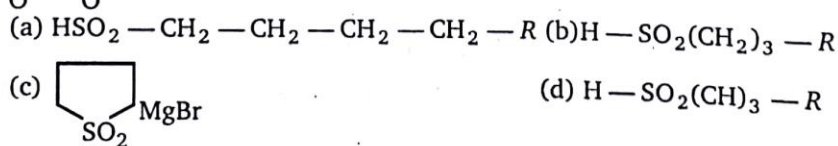
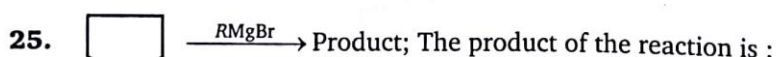
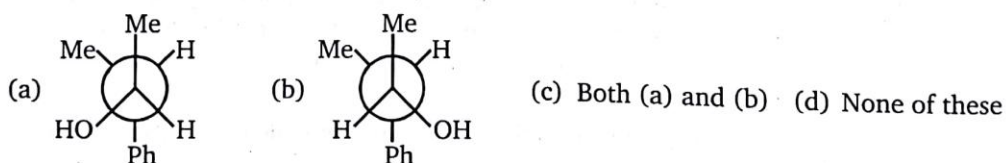
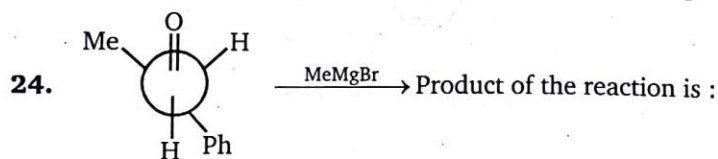
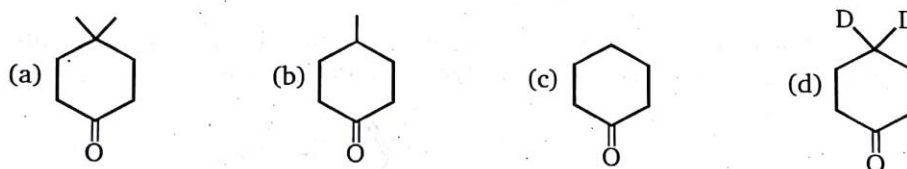
(a) 4,4-dimethylcyclohexanone
(b) 4-methylcyclohexanone
(c) cyclohexanone
(d) 4,4-dideuteriocyclohexanone (D, D)

24. Newman projection (front: Me, C=O, H; back: H, Ph) $\xrightarrow{\text{MeMgBr}}$ Product of the reaction is :

(c) Both (a) and (b) (d) None of these

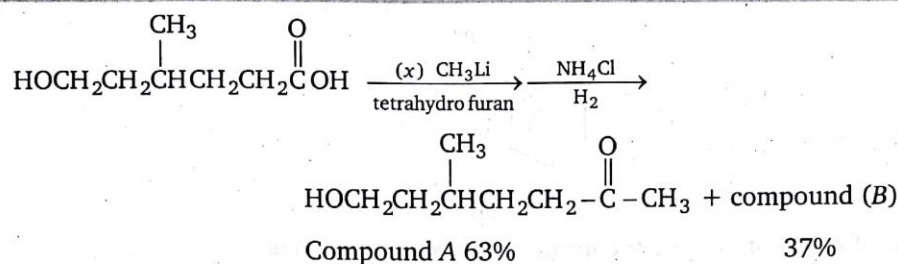
25. Sulfolane (ring with S, O, O) $\xrightarrow{RMgBr}$ Product; The product of the reaction is :

(a) $HSO_2—CH_2—CH_2—CH_2—CH_2—R$ (b) $H—SO_2(CH_2)_3—R$

(c) ring with SO_2 and MgBr (d) $H—SO_2(CH)_3—R$

26. When carboxylic acid reacts with organolithium reagents to give ketones, side reaction sometimes occur. For example,

$$HOCH_2CH_2\overset{CH_3}{\overset{|}{C}}HCH_2CH_2\overset{O}{\overset{||}{C}}OH \xrightarrow[\text{tetrahydro furan}]{(x)\ CH_3Li} \xrightarrow[H_2]{NH_4Cl}$$

$$HOCH_2CH_2\overset{CH_3}{\overset{|}{C}}HCH_2CH_2-\overset{O}{\overset{||}{C}}-CH_3 + \text{compound } (B)$$

Compound A 63% 37%

Value of (x) in above reaction is :

(a) 2 (b) 3 (c) 4 (d) 5

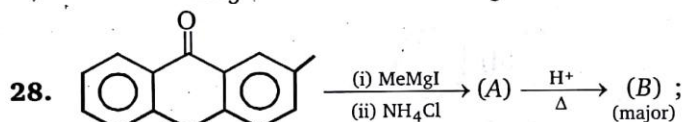
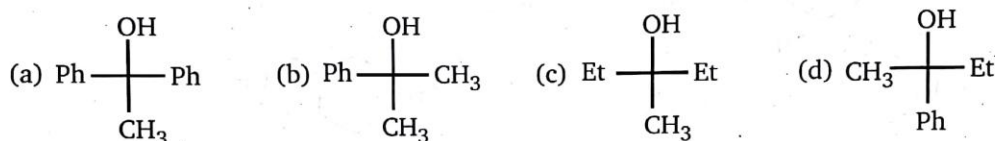
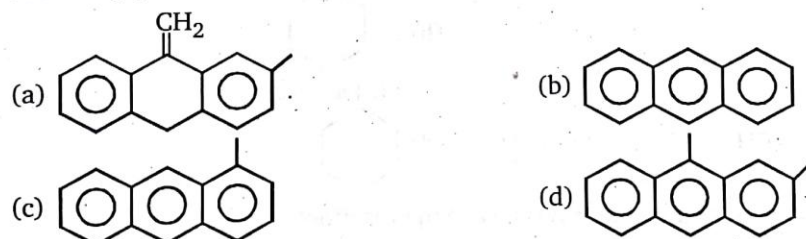
27. Which of the following alcohol can not be prepared by the reaction of acid chloride with excess of Grignard reagent followed by acidification ?

(a) Ph–C(OH)(CH₃)–Ph (b) Ph–C(OH)(CH₃)–CH₃ (c) Et–C(OH)(CH₃)–Et (d) CH₃–C(OH)(Ph)–Et

28.

$\xrightarrow[\text{(ii) } NH_4Cl]{\text{(i) MeMgI}} (A) \xrightarrow[\Delta]{H^+} \underset{\text{(major)}}{(B)}$;

Product (B) of the above reaction is :

(a) (b) (c) (d)

29. The reaction of elemental sulphur with Grignard reagent followed by acidification leads to the formation of

(a) mercaptan (b) sulphoxide (c) thioether (d) sulphonic acid

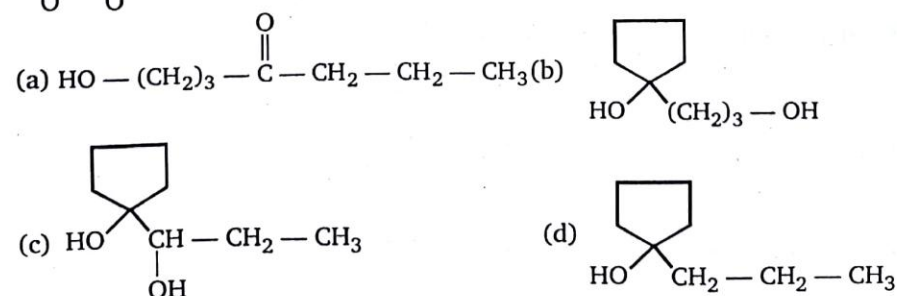
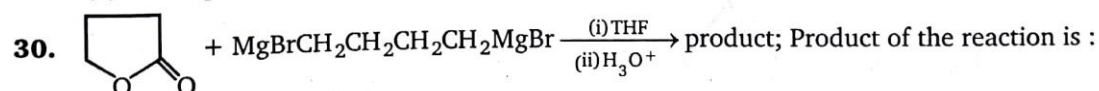
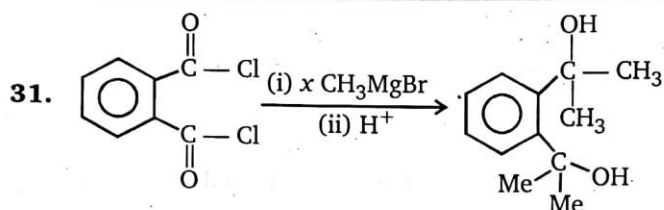
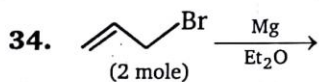
30. (γ-butyrolactone) + $MgBrCH_2CH_2CH_2CH_2MgBr \xrightarrow[\text{(ii)} H_3O^+]{\text{(i) THF}}$ product; Product of the reaction is :

(a) $HO-(CH_2)_3-\overset{O}{\overset{||}{C}}-CH_2-CH_2-CH_3$

(b) cyclopentane with HO and $(CH_2)_3-OH$ on the same carbon

(c) cyclopentane with HO and $\underset{OH}{\underset{|}{C}H}-CH_2-CH_3$ on the same carbon

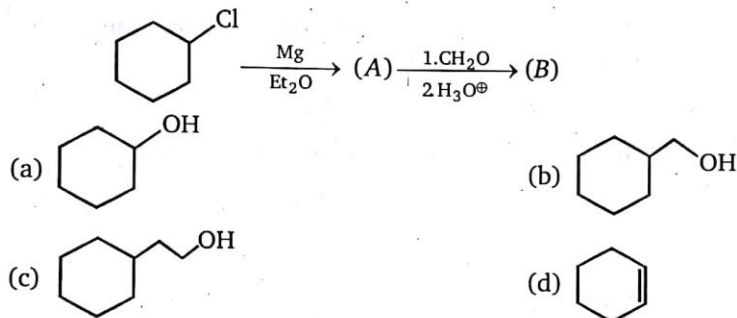
(d) cyclopentane with HO and $CH_2-CH_2-CH_3$ on the same carbon

31. $C_6H_4(COCl)_2$ (o-phthaloyl chloride) $\xrightarrow[\text{(ii) } H^+]{\text{(i) } x\, CH_3MgBr}$ $C_6H_4[C(OH)(CH_3)_2]_2$

Number of moles of CH_3MgBr consumed in above reaction is :

(a) 2 (b) 4 (c) 6 (d) 8

32. End product of the given reaction is :

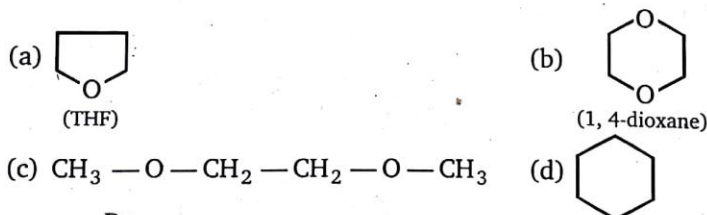
Cyclohexyl chloride $\xrightarrow[Et_2O]{Mg}$ (A) $\xrightarrow[2\, H_3O^{\oplus}]{1. CH_2O}$ (B)

(a) Cyclohexanol (b) Cyclohexylmethanol ($C_6H_{11}CH_2OH$)

(c) 2-Cyclohexylethanol ($C_6H_{11}CH_2CH_2OH$) (d) Cyclohexene

33. Which of the following compound is not a suitable solvent for Grignard reaction ?

(a)
(THF)

(b) (1, 4-dioxane)

(c) $CH_3-O-CH_2-CH_2-O-CH_3$ (d)

34. $CH_2=CH-CH_2Br$ (2 mole) $\xrightarrow[Et_2O]{Mg}$ Predict major product of the reaction :

(a) $CH_2=CH-CH=CH_2$ (b) $CH_2=CH-CH_2-CH_2-CH=CH_2$ (c) $CH_2=C=CH_2$ (d) $CH_2=CH-CH=CH-CH_3$

35. Which of the following reaction sequences would be the best for synthesis of t-butyl alcohol ?

(a) $CH_3CH_2MgBr + CH_2-CH_2$ (ethylene oxide) $\xrightarrow{Et_2O} \xrightarrow{H_3O^{\oplus}}$

(b) $CH_3CH_2CH_2MgBr \xrightarrow[Et_2O]{CO_2} \xrightarrow{H_3O^{\oplus}}$

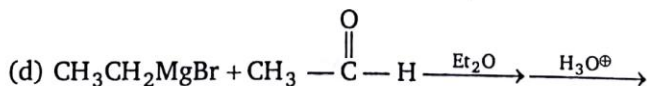
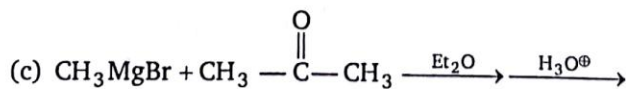
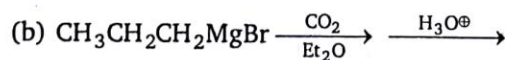
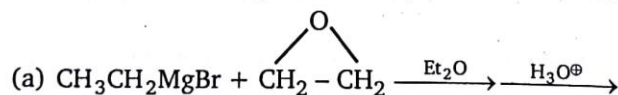
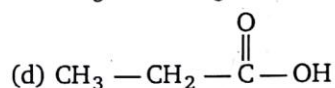
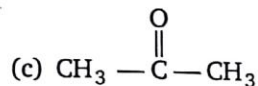
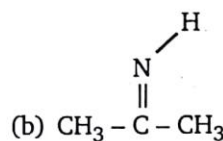
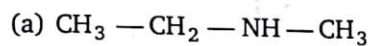
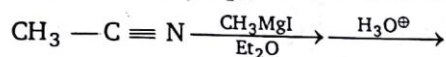
(c) $CH_3MgBr + CH_3-\overset{O}{\overset{\|}{C}}-CH_3 \xrightarrow{Et_2O} \xrightarrow{H_3O^{\oplus}}$

(d) $CH_3CH_2MgBr + CH_3-\overset{O}{\overset{\|}{C}}-H \xrightarrow{Et_2O} \xrightarrow{H_3O^{\oplus}}$

36. What is the major product of the following reaction ?

$CH_3-C\equiv N \xrightarrow[Et_2O]{CH_3MgI} \xrightarrow{H_3O^\oplus}$

(a) $CH_3-CH_2-NH-CH_3$ (b) $CH_3-C(=N-H)-CH_3$

(c) $CH_3-C(=O)-CH_3$ (d) $CH_3-CH_2-C(=O)-OH$

37. $H-C(=O)-CH_3 \xrightarrow[(2)\,H^+]{(1)\,PhMgBr}$ Products; Product obtained in this reaction are :

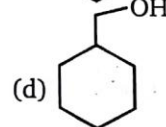
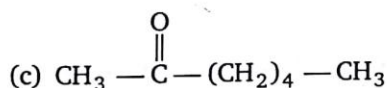
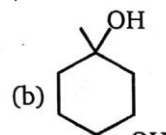
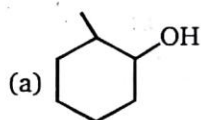
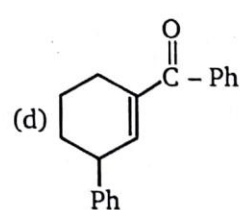
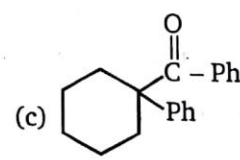
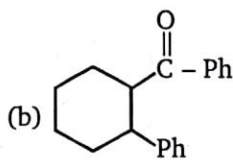
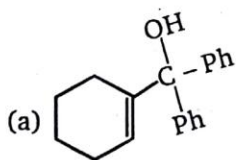
(a) diastereomers (b) racemic (c) pure enantiomer (d) meso

38. $CH_3CO_2Et + (CH_2)_5(MgBr)_2 \xrightarrow{(2)\,H^+} \underset{(A)}{C_7H_{14}O}$; compound (A) will be :

(a) [2-methylcyclohexanol] (b) [1-methylcyclohexanol]

(c) $CH_3-C(=O)-(CH_2)_4-CH_3$ (d) [cyclohexylmethanol]

39. [1-cyclohexenyl phenyl ketone, $C(=O)-Ph$] $\xrightarrow[(2)\,H^+]{(1)\,PhMgBr/CuCl} \underset{C_{19}H_{20}O}{(A)}$; A will be :

(a) [cyclohexenyl–C(OH)(Ph)–Ph] (b) [2-phenylcyclohexyl–C(=O)–Ph] (c) [1-phenylcyclohexyl–C(=O)–Ph] (d) [3-phenylcyclohexenyl–C(=O)–Ph]

40. [3,5-dimethoxybenzyl bromide: MeO, OMe, CH_2Br] $\xrightarrow[(n-Bu=n-butyl\ group)]{n-Bu_2CuLi}$ Product of the reaction will be :

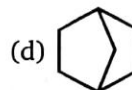
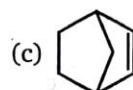
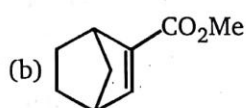
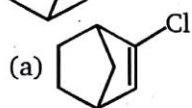
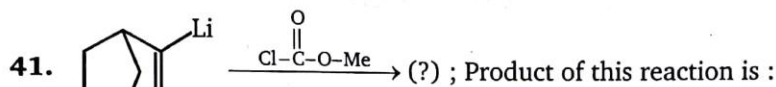
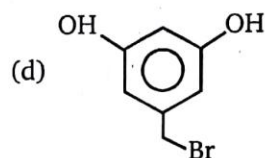
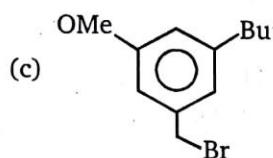
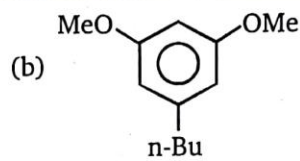
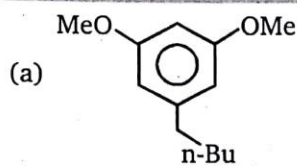
(a) MeO, OMe, n-Bu (benzene ring: 3,5-dimethoxy, CH_2–n-Bu)

(b) MeO, OMe, n-Bu (benzene ring: 3,5-dimethoxy, n-Bu)

(c) OMe, Bu, Br (benzene ring: OMe, Bu, CH_2Br)

(d) OH, OH, Br (benzene ring: 3,5-dihydroxy, CH_2Br)

41. (Norbornenyl–Li) $\xrightarrow{Cl-\overset{O}{\overset{\|}{C}}-O-Me}$ (?) ; Product of this reaction is :

(a) (Norbornenyl–Cl) (b) (Norbornenyl–CO_2Me) (c) (Norbornene) (d) (Norbornane)

42. Ethyl acetoacetate when reacts with one mole methyl magnesium iodide then product of reaction will be :

(a) $CH_3-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-CH_3$

(b) $CH_3-\underset{CH_3}{\underset{|}{\overset{O^{\ominus}\overset{\oplus}{M}gBr}{\overset{|}{C}}}}-CH_2-\overset{O}{\overset{\|}{C}}-CH_3$

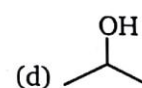
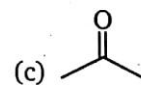
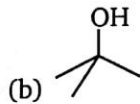
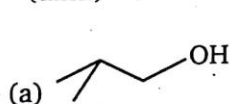
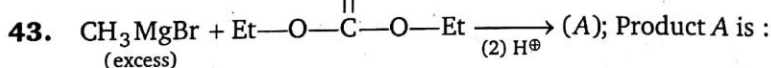
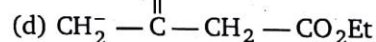
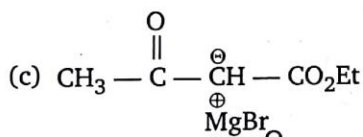
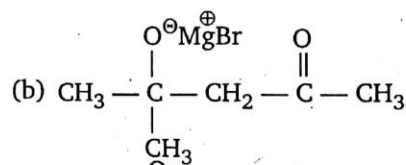
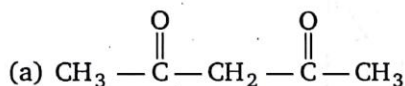
(c) $CH_3-\overset{O}{\overset{\|}{C}}-\underset{\overset{\oplus}{M}gBr}{\overset{\ominus}{C}H}-CO_2Et$

(d) $CH_2^{-}-\overset{O}{\overset{\|}{C}}-CH_2-CO_2Et$

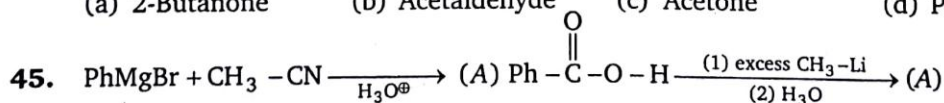
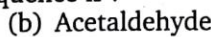
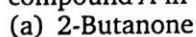
43. $\underset{\text{(excess)}}{CH_3MgBr} + Et-O-\overset{O}{\overset{\|}{C}}-O-Et \xrightarrow[\text{(2) }H^{\oplus}]{} (A)$; Product A is :

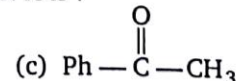
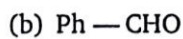
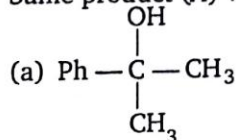
(a) (b)

(c)

(d)

44. For the sequence of reactions, $A \xrightarrow[\text{ether}]{C_2H_5MgI} B \xrightarrow{H_2O/H^+}$ tert-Pentyl alcohol. The compound A in the sequence is :

(a) 2-Butanone (b) Acetaldehyde (c) Acetone (d) Propanal

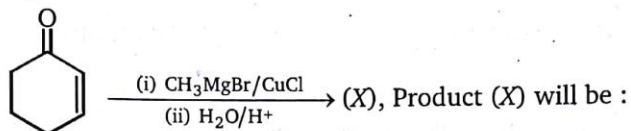
45. $PhMgBr + CH_3-CN \xrightarrow[H_3O^{\oplus}]{} (A)$ $Ph-\overset{O}{\overset{\|}{C}}-O-H \xrightarrow[\text{(2) }H_3O]{\text{(1) excess }CH_3-Li} (A)$

Same product (A) will form in both reactions. A is :

(a) $Ph-\underset{CH_3}{\underset{|}{\overset{OH}{\overset{|}{C}}}}-CH_3$ (b) $Ph-CHO$ (c) $Ph-\overset{O}{\overset{\|}{C}}-CH_3$ (d) $Ph-CH_2-CO_2H$

46. Which of the following Grignard reagent can be prepared ?

(a) $Br-Mg-CH_2-CH_2-CH_2-O-H$ (b) $Br-Mg-CH_2-CH_2-SH$

(c) $BrMg-CH_2-CH_2-NH_2$ (d) $BrMg-CH_2-CH_2-N(CH_3)-CH_3$

47. In the reaction sequence :

Cyclohex-2-enone $\xrightarrow[\text{(ii) } H_2O/H^+]{\text{(i) } CH_3MgBr/CuCl}$ (X), Product (X) will be :

(a) (b) (c) (d)

48. $(C_2H_5O)_2CO \xrightarrow[H_3O^+]{CH_3MgBr(excess)} A$. A (alcohol) can also be obtained by :

(a) $CH_3CH_2CHO \xrightarrow[H_3O^+]{CH_3MgBr(2mol)}$ (b) $CH_3\overset{O}{\overset{\|}{C}}OC_2H_5 \xrightarrow[H_3O^+]{CH_3MgBr(2\ mol)}$

(c) $CH_3\overset{O}{\overset{\|}{C}}CH_3 \xrightarrow[H_3O^+]{CH_3MgBr\ (1mol)}$ (d) as in (b) and (c)

49. The principal product of the reaction between methyl butanoate and 2 moles of CH_3MgBr after hydrolysis is :

(a) $C_3H_7COCH_3$ (b) $C_3H_7C(OH)(CH_3)_2$

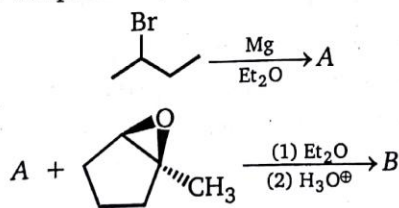
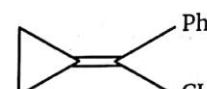
(c) $C_3H_7CHOHCH_3$ (d) $C_3H_7COCH(CH_3)_2$

50. Which of the following compounds will form hydrocarbon on reaction with Grignard reagent ?

(a) CH_3CH_2OH (b) CH_3CHO (c) CH_3COCH_3 (d) $CH_3CO_2CH_3$

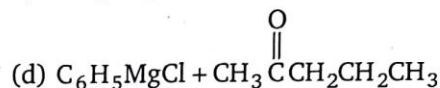
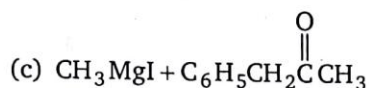
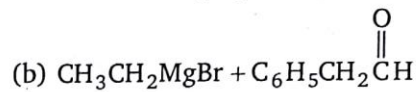
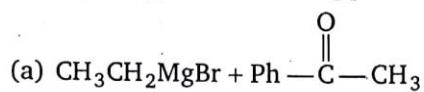
51. What is the product (B) of the following reaction sequence ?

2-Bromobutane $\xrightarrow[Et_2O]{Mg} A$

A + (epoxide, CH_3) $\xrightarrow[\text{(2) } H_3O^{\oplus}]{\text{(1) } Et_2O} B$

(a) (b) (c) (d)

52. Which, if any, of the following pairs of reagents could be used to prepare 2-phenyl-2-butanol?

(a) $CH_3CH_2MgBr + Ph-\overset{O}{\overset{||}{C}}-CH_3$ (b) $CH_3CH_2MgBr + C_6H_5CH_2\overset{O}{\overset{||}{C}}H$

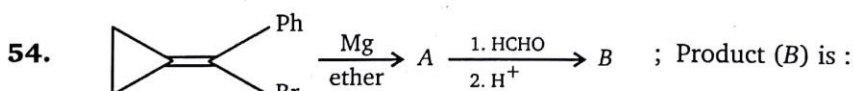
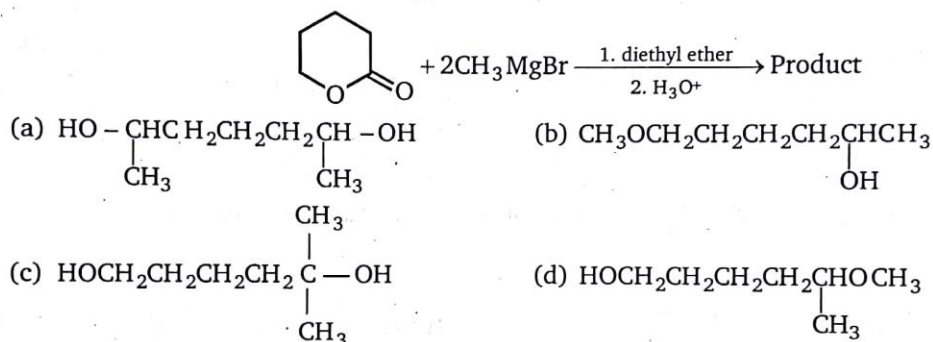
(c) $CH_3MgI + C_6H_5CH_2\overset{O}{\overset{||}{C}}CH_3$ (d) $C_6H_5MgCl + CH_3\overset{O}{\overset{||}{C}}CH_2CH_2CH_3$

53. What is the product of the following reaction?

$$\text{(δ-valerolactone)} + 2CH_3MgBr \xrightarrow[2.\ H_3O^+]{1.\ \text{diethyl ether}} \text{Product}$$

(a) $HO-\underset{CH_3}{\underset{|}{C}}HCH_2CH_2CH_2\underset{CH_3}{\underset{|}{C}}H-OH$ (b) $CH_3OCH_2CH_2CH_2CH_2\underset{OH}{\underset{|}{C}}HCH_3$

(c) $HOCH_2CH_2CH_2CH_2\overset{CH_3}{\overset{|}{\underset{CH_3}{\underset{|}{C}}}}-OH$ (d) $HOCH_2CH_2CH_2CH_2\underset{CH_3}{\underset{|}{C}}HOCH_3$

54. $\text{(cyclopropylidene)}=C(Ph)(Br) \xrightarrow[\text{ether}]{Mg} A \xrightarrow[2.\ H^+]{1.\ HCHO} B$; Product (B) is :

(a) $\text{(cyclopropylidene)}=C(Ph)(CH_2-OH)$

(b) $Ph-C\equiv C-CH_2-CH_2-CH_2-OH$

(c) $Ph-C\equiv C-CH_2-CH_2-OH$

(d) $Ph-CH_2-C\equiv C-CH_2-CH_2-OH$

55. What sequence of steps represents the best synthesis of 4-heptanol $(CH_3CH_2CH_2)_2CHOH$?

(a) $CH_3CH_2CH_2MgBr$(2moles) + formaldehyde ($H_2C=O$) in diethyl ether followed by H_3O^+

(b) $CH_3CH_2CH_2MgBr$ + butanol ($CH_3CH_2CH_2CH=O$) in diethyl ether followed by H_3O^+

(c) $CH_3CH_2CH_2CH_2MgBr$ + acetone [$(CH_3)_2C=O$] in diethyl ether followed by H_3O^+

(d) $(CH_3CH_2CH_2)_2CHMgBr$ + formaldehyde ($H_2C=O$) in diethyl ether followed by H_3O^+

56. Et, H, Me–C–C(=O)–CH₂CH₃ $\xrightarrow[(2)\ NH_4Cl]{(1)\ MeMgBr}$ Comment on stereochemistry of products :

(a) diastereomers (b) racemic

(c) single stereoisomer (d) meso

57.
$$\begin{array}{l} CH_2-OH \\ | \\ CH-OH \\ | \\ CH_2-SH \end{array} + \underset{\text{(Excess)}}{CH_3MgBr} \longrightarrow xCH_4$$

What is the value of x in the above reaction ?

(a) 1 (b) 2

(c) 3 (d) 4

58. 0.40 g of an organic compound (A), (M.F.- C_5H_8O) reacts with x mole of CH_3MgBr to liberate 224 mL of a gas at STP. With excess of H_2, (A) gives pentan-1-ol. The correct structure of (A) is :

(a) $CH_3-C\equiv C-CH_2-CH_2-OH$

(b) $CH_3-CH_2-C\equiv C-CH_2-OH$

(c) $H-C\equiv C-CH_2-CH_2-CH_2-OH$

(d) $H-C\equiv C-CH_2-\underset{\underset{OH}{|}}{CH}-CH_3$

59. $CH_3-CH=CH_2 \xrightarrow[\text{hv (low conc.)}]{Br_2} \xrightarrow[\text{Dry ether}]{Mg} \xrightarrow[NH_4Cl]{CH_3-\overset{\overset{O}{||}}{C}-CH_3} \xrightarrow[\Delta]{H^+} \underset{\text{(major)}}{(X)}$

End product (X) of the above reaction is :

(a) $CH_2=CH-CH_2-\overset{\overset{CH_2}{||}}{C}-CH_3$

(b) $H_2C=CH-CH=\underset{\underset{CH_3}{|}}{C}-CH_3$

(c) $H_2C=CH-CH_2-\overset{\overset{OH}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_3$

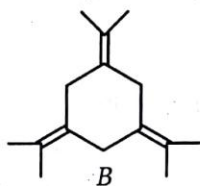
(d) $H_2C=CH-CH_2-CH-\underset{\underset{CH_3}{|}}{CH_2}-OH$

60. $\underset{\diagdown O \diagup}{CH_2-CH}-CH_2-Br \xrightarrow[\text{dry ethane}]{Mg} (A) \xrightarrow{CH_3I} (B)$; Product (B) is :

(a) $\underset{\diagdown O \diagup}{CH_2-CH}-CH_2-CH_3$ (b) $CH_3-O-CH_2-CH_2-CH_3$

(c) $H_2C=CH-CH_2-O-CH_3$ (d) $\underset{\diagdown O \diagup}{H_2C-CH}-CH_3$

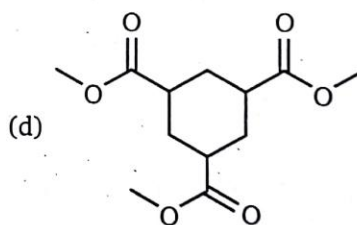
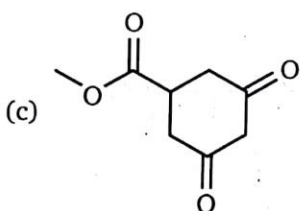
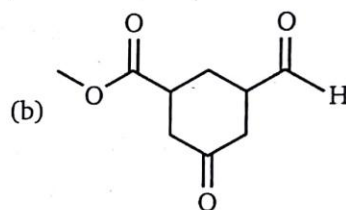
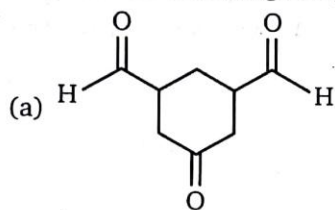
61. Compound A was treated with a large excess of CH_3MgBr. The resulting product was exposed to $POCl_3$/pyridine to give compound B, as one of many products:

B

Which of the following compounds can be A?

(a)

(b)

(c)

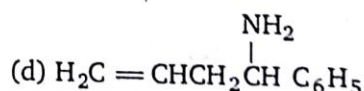
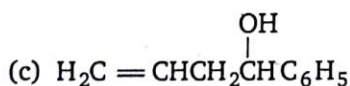
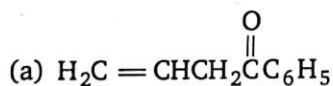
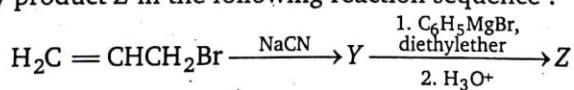
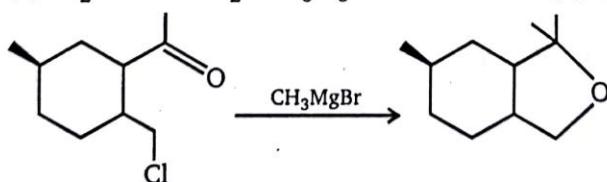
(d)

62. Identify product Z in the following reaction sequence:

$$H_2C=CHCH_2Br \xrightarrow{NaCN} Y \xrightarrow[\text{2. } H_3O^+]{\text{1. } C_6H_5MgBr, \text{ diethylether}} Z$$

(a) $H_2C=CHCH_2\overset{O}{\overset{\|}{C}}C_6H_5$

(b) $H_2C=CHCH_2NH\overset{O}{\overset{\|}{C}}C_6H_5$

(c) $H_2C=CHCH_2\overset{OH}{\overset{|}{C}H}C_6H_5$

(d) $H_2C=CHCH_2\overset{NH_2}{\overset{|}{C}H}\ C_6H_5$

63.

(Consider all steps and intermediate) correct statement is :

(a) Nucleophilic addition

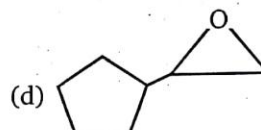
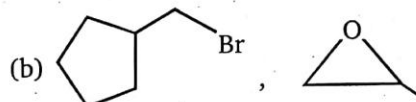
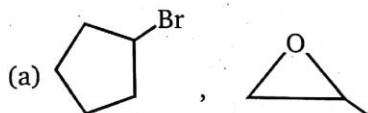
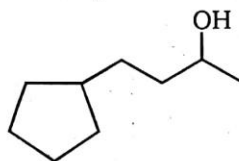
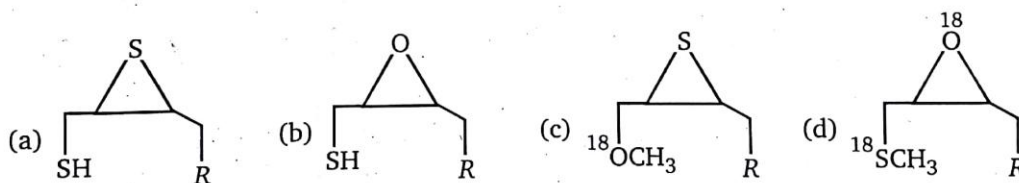
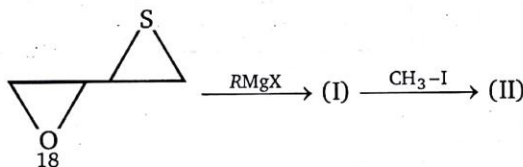
(b) Nucleophilic substitution reaction

(c) Product obtained is chiral

(d) All

64. Which combination(s) of alkyl bromide and epoxide can be used to prepare the following product by addition of the Grignard reagent derived from the alkyl bromide to the epoxide ?

(a) (b)

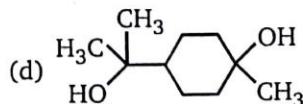
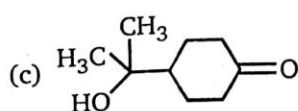
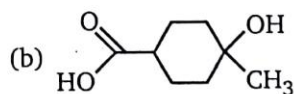
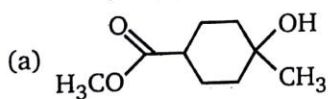
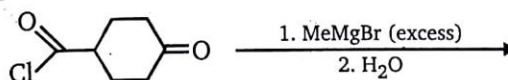
(c) (d)

65. What will be the final major product ?

66. Give the expected product of the following reaction.

1. MeMgBr (excess)
2. H_2O

(a) (b)

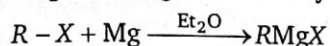
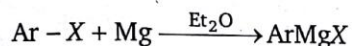
(c) (d)

ANSWERS — LEVEL 1

1.	(b)	**2.**	(d)	**3.**	(b)	**4.**	(d)	**5.**	(c)	**6.**	(d)	**7.**	(c)	**8.**	(c)
9.	(d)	**10.**	(c)	**11.**	(b)	**12.**	(b)	**13.**	(b)	**14.**	(c)	**15.**	(b)	**16.**	(b)
17.	(d)	**18.**	(d)	**19.**	(d)	**20.**	(d)	**21.**	(c)	**22.**	(b)	**23.**	(b)	**24.**	(c)
25.	(c)	**26.**	(b)	**27.**	(d)	**28.**	(d)	**29.**	(a)	**30.**	(b)	**31.**	(b)	**32.**	(b)
33.	(d)	**34.**	(b)	**35.**	(c)	**36.**	(c)	**37.**	(b)	**38.**	(b)	**39.**	(b)	**40.**	(a)
41.	(b)	**42.**	(c)	**43.**	(b)	**44.**	(c)	**45.**	(c)	**46.**	(d)	**47.**	(b)	**48.**	(d)
49.	(b)	**50.**	(a)	**51.**	(a)	**52.**	(a)	**53.**	(c)	**54.**	(b)	**55.**	(b)	**56.**	(a)
57.	(c)	**58.**	(c)	**59.**	(b)	**60.**	(c)	**61.**	(d)	**62.**	(a)	**63.**	(d)	**64.**	(b)
65.	(c)	**66.**	(d)												

LEVEL-2

1. Comprehension

Grignard reagent is usually prepared by

$R-X+\text{Mg}\xrightarrow{\text{Et}_2\text{O}} R\text{Mg}X$ Grignard reagent

$\text{Ar}-X+\text{Mg}\xrightarrow{\text{Et}_2\text{O}} \text{ArMg}X$ Grignard reagent

Grignard reagent acts as a strong base. Grignard reagent carry out nucleophilic attack in absence of acidic hydrogen. Grignard reagent form complex with its ether solvent. Complex formation with molecule of ether is an important factor in the formation and stability of Grignard reagent.

A. What is the correct order of reactivity of halides with magnesium ?

(a) $R-\text{Cl}>R-\text{Br}>R-\text{I}$ (b) $R-\text{Br}>R-\text{Cl}>R-\text{I}$

(c) $R-\text{I}>R-\text{Br}>R-\text{Cl}$ (d) $R-\text{I}=R-\text{Br}=R-\text{Cl}$

B. Which of the following will undergo acid-base reaction with Grignard reagent ?

(a) $\text{HC}\equiv\text{CH}$ (b) $R-\text{OH}$

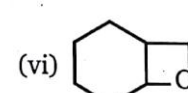
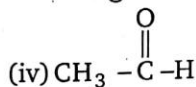
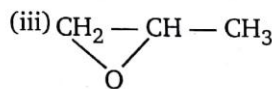
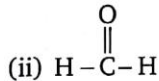
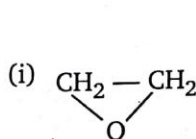
(c) $R-\text{CO}_2\text{H}$ (d) All of these

C. Which of the following reactants give primary alcohol as a major product when reacts with $R\text{Mg}X$ followed by acidification ?

(i)

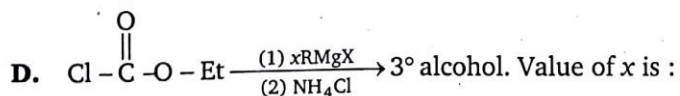
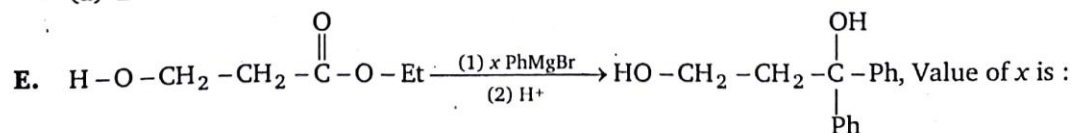
(ii) $\text{H}-\overset{\text{O}}{\overset{\|}{\text{C}}}-\text{H}$

(iii)

(iv) $\text{CH}_3-\overset{\text{O}}{\overset{\|}{\text{C}}}-\text{H}$ (v) [oxetane] (vi) [cyclohexane fused oxetane]

(a) i, ii, v (b) i, ii, v, vi (c) ii, iv, vi (d) v, iv, iii, vi

D. $\text{Cl}-\overset{\text{O}}{\overset{\|}{\text{C}}}-\text{O}-\text{Et}\xrightarrow[\text{(2) NH}_4\text{Cl}]{\text{(1) }x\text{RMgX}} 3^\circ$ alcohol. Value of x is :

(a) 2 (b) 3 (c) 4 (d) 5

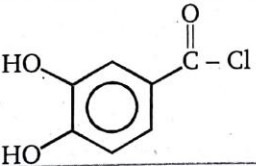
E. $\text{H}-\text{O}-\text{CH}_2-\text{CH}_2-\overset{\text{O}}{\overset{\|}{\text{C}}}-\text{O}-\text{Et}\xrightarrow[\text{(2) H}^+]{\text{(1) }x\text{ PhMgBr}}\text{HO}-\text{CH}_2-\text{CH}_2-\underset{\text{Ph}}{\underset{|}{\overset{\text{OH}}{\overset{|}{\text{C}}}}}-\text{Ph}$, Value of x is :

(a) 2 (b) 3 (c) 4 (d) 5

F. Which of the following Grignard reagents is not possible ?

(a) $HS-CH_2-CH_2-CH_2MgBr$ (b) $HO-CH_2-CH_2-CH_2MgBr$
(c) $NH_2-CH_2-CH_2-CH_2MgBr$ (d) All of these

G. How many different Grignard reagents when react with EtOH, give *n*-butane as product (excluding stereoisomerism).

(a) 1 (b) 2 (c) 3 (d) 4

2. Match the column I and II. (Matrix)

	Column (I) Reactant		Column (II) Product
(a)	$PhMgBr + Cl-\overset{O}{\overset{\parallel}{C}}-O-Et \xrightarrow[H^{\oplus}]{}$ (excess)	**(p)**	$Ph-CH_2-OH$
(b)	$PhMgBr + H-\overset{O}{\overset{\parallel}{C}}-O-Et \xrightarrow[H^{\oplus}]{}$ (excess)	**(q)**	$Ph-\underset{OH}{\underset{\mid}{CH}}-Ph$
(c)	$PhMgBr + H-\overset{O}{\overset{\parallel}{C}}-H \xrightarrow[H^{\oplus}]{}$ (excess)	**(r)**	$Ph-\overset{OH}{\overset{\mid}{\underset{Ph}{\underset{\mid}{C}}}}-Ph$
(d)	$PhMgBr + CH_3-\overset{O}{\overset{\parallel}{C}}-O-Et \xrightarrow[H^{\oplus}]{}$ (excess)	**(s)**	$Ph-\overset{OH}{\overset{\mid}{\underset{CH_3}{\underset{\mid}{C}}}}-Ph$

3. Match the column I and II. (Matrix)

	Column (I) Reaction		Column (II) Reactant
(a)	$PhMgBr + (A) \xrightarrow[H^{\oplus}]{} 1^{o}$alcohol	**(p)**	$CH_3-\overset{O}{\overset{\parallel}{C}}-CH_2-\overset{O}{\overset{\parallel}{C}}-CH_3$
(b)	$PhMgBr + (B) \xrightarrow[H^{\oplus}]{} 2^{o}$alcohol	**(q)**	$CH_3-\overset{O}{\overset{\parallel}{C}}-CH_3$
(c)	$PhMgBr + (C) \xrightarrow[H^{\oplus}]{} 3^{o}$alcohol	**(r)**	$CH_3-\overset{O}{\overset{\parallel}{C}}-H$
(d)	$PhMgBr + (D) \xrightarrow[H^{\oplus}]{}$ (benzene)	**(s)**	$H-\overset{O}{\overset{\parallel}{C}}-H$

Match the missing reactant *A, B, C, D*

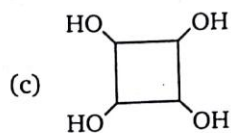
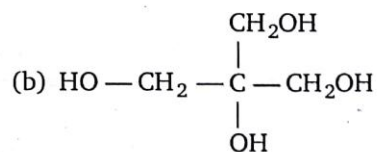
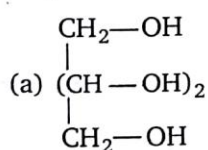
4. Match the column I and II. (Matrix)

	Column (I) Reaction		Column (II) Moles of PhMgBr used
(a)	$PhMgBr + Et-O-\overset{O}{\overset{\|\|}{C}}-O-Et \xrightarrow[H^{\oplus}]{} 3^{o}alcohol$	(p)	1
(b)	$PhMgBr + HO-CH_2-\overset{O}{\overset{\|\|}{C}}-CH_3 \xrightarrow[H^{\oplus}]{} 3^{\circ}$ alcohol	(q)	2
(c)	$PhMgBr + CH_3-\overset{O}{\overset{\|\|}{C}}-CH_3 \xrightarrow[H^{\oplus}]{} 3^{o}alcohol$	(r)	3
(d)	PhMgBr + (3,4-dihydroxyphenyl)$-\overset{O}{\overset{\|\|}{C}}-Cl \xrightarrow[H^{\oplus}]{} 3^{o}alcohol$	(s)	4

5. When 20 g of a compound (*A*) (M.F. = $C_4H_{10}O_4$) reacts with excess of CH_3MgBr, 14.6 L of CH_4 is obtained at STP. What is structural formula of (*A*) ?

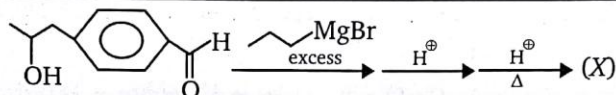
(a) CH_2-OH / $(CH-OH)_2$ / CH_2-OH (i.e. $HOCH_2-(CH-OH)_2-CH_2OH$)

(b) $HO-CH_2-\underset{OH}{\overset{CH_2OH}{C}}-CH_2OH$

(c) Cyclobutane ring bearing HO, OH, HO, OH at the four corners

(d) Both (a) & (b)

SUBJECTIVE PROBLEMS

1.

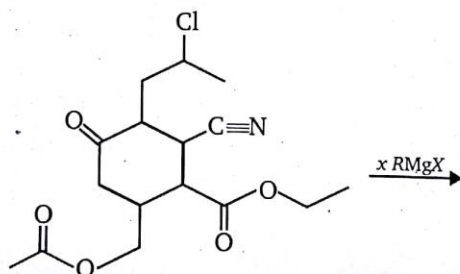
(Reaction scheme: substrate with OH and CHO groups, reagents: ~MgBr (excess), $H^{\oplus}$, $H^{\oplus}$/Δ → (X))

How many geometrical isomer of (X) is possible ?

2. How many isomer of C_4H_8O when reacts with CH_3MgBr followed by acidification to give 2° alcohol (only consider carbonyl isomers)?

(including stereoisomer)

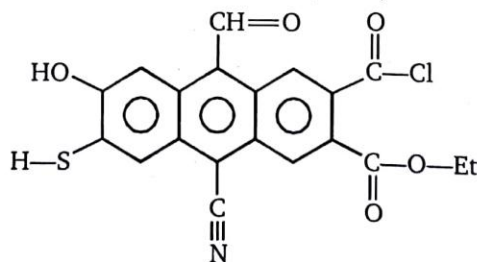
3.

Total number of RMgX are consumed in the following reaction

(Structure with Cl, C≡N, O groups; reagent: x RMgX)

4. How many isomers of $C_4H_{10}O$ reacts with CH_3MgBr to evolve CH_4 gas ? (Excluding stereoisomer)

5. How many carbonyl isomers of $C_5H_{10}O$ which reacts with PhMgBr to give racemic mixture ?

6. How many moles of Grignard reagent will consume when it reacts with following compound?

(Structure with substituents: CH═O, C(=O)—Cl, HO, H—S, C—O—Et (C=O), C≡N)

ANSWERS — LEVEL 2

1. A – c; B – d; C – a; D – b; E – b; F – d; G – b
2. a – r; b – q; c – p; d – s
3. a – s; b – r; c – q; d – p
4. a – r; b – q; c – p; d – s
5. (d)

Subjective Problems

1. 4 **2.** 2 **3.** 7 **4.** 4 **5.** 5 **6.** 8

HYDROCARBONS (ALKANES)

1. On halogenation, an alkane gives only one monohalogenated product. The alkane may be :

(a) 2-methyl butane (b) 2, 2-dimethyl propane
(c) cyclopentane (d) both (b) and (c)

2. Which of the following compounds can be best prepared by Wurtz-reaction ?

(a) Iso-butane (b) *n*-butane
(c) *n*-pentane (d) Iso-pentane

3. A hydrocarbon *A* (V.D. = 36) forms only one monochloro substitution product. *A* will be :

(a) iso-pentane (b) neo-pentane
(c) cyclohexane (d) methyl-cyclohexane

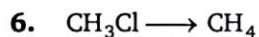
4. Ethyl iodide and *n*-propyl iodide are allowed to undergo Wurtz reaction. The alkane which will not be obtained in this reaction is :

(a) butane (b) propane
(c) pentane (d) hexane

5. $CH_3—\underset{\underset{CH_3}{|}}{CH}—CH_2—CH_3 \xrightarrow[h\nu]{Cl_2}$

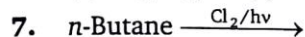
Number of chiral centers generated during monochlorination in the above reaction :

(a) 1 (b) 2 (c) 3 (d) 4

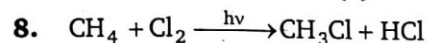
6. $CH_3Cl \longrightarrow CH_4$

Above conversion can be achieved by :

(a) Zn / H^+ (b) $LiAlH_4$

(c) Mg / (ether) then H_2O (d) all of these

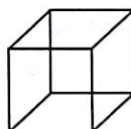
7. n-Butane $\xrightarrow{Cl_2/h\nu}$

Give the total number of monochloro products(including stereoisomers), which are possible in the above reaction.

(a) 2 (b) 3 (c) 4 (d) 5

8. $CH_4 + Cl_2 \xrightarrow{h\nu} CH_3Cl + HCl$

To obtain high yields of CH_3Cl, the ratio of CH_4 to Cl_2 must be :

(a) high (b) low

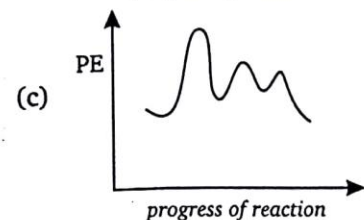
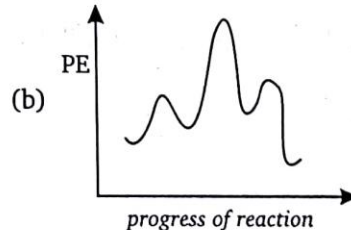
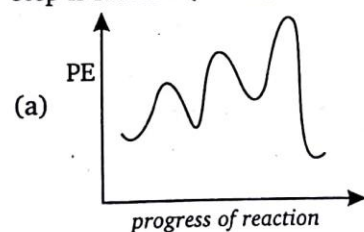
(c) equal (d) can't be predicted

9. Double bond equivalent of cubane is :

Cubane

(a) 4 (b) 5 (c) 6 (d) 7

10. How many bond cleavages are required to convert cubane into non-cyclic skeleton ?

(a) 2 (b) 3 (c) 4 (d) 5

11. Draw an energy profile diagram for a three step reaction in which first step is slowest and last step is fastest. (Assume that reaction is exothermic)

(a)

(b)

(c)

(d) None of these

12. $CH_3—CH(CH_3)—CH_2—CH_3 \xrightarrow[h\nu]{Cl_2} (x)$ = Number of monochloro product including stereoisomers.

(a) 4 (b) 5 (c) 6 (d) 7

13.

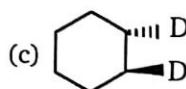
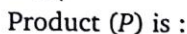
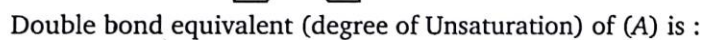
Product (P) is :

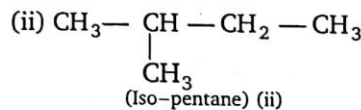
(d) both (b) & (c)

14. $(A) \xrightarrow{H_2(1mole)/Pt}$ [bicyclic structure]

Double bond equivalent (degree of Unsaturation) of (A) is :

(a) 1 (b) 2 (c) 3 (d) 4

15. Arrange the following alkanes in decreasing order of their heats of combustion.

(i) $CH_3—C(CH_3)_2—CH_3$ (Neo-pentane) (i)

(ii) $CH_3—CH(CH_3)—CH_2—CH_3$ (Iso-pentane) (ii)

(iii) $CH_3—CH_2—CH_2—CH_2—CH_3$ (n-pentane)

(a) (i) > (ii) > (iii) (b) (iii) > (i) > (ii)

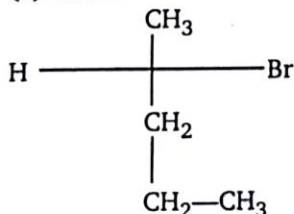
(c) (iii) > (ii) > (i) (d) (i) > (iii) > (ii)

16.

Product of the above reaction will be :

(a) Racemic mixture (b) Diastereomers

(c) Meso (d) Constitutional isomers

17. [Fischer projection: CH_3 top; H left, Br right; CH_2; $CH_2—CH_3$] $+ Br_2 \xrightarrow{300°C}$

Which of the following compound will not be obtained as a product in the above reaction ?

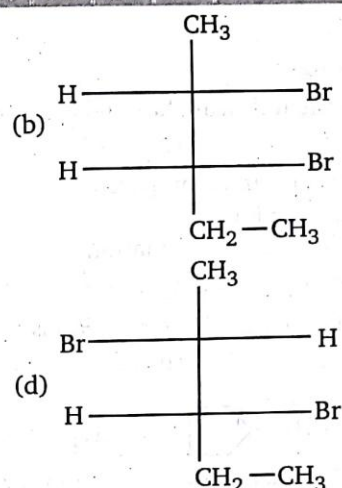
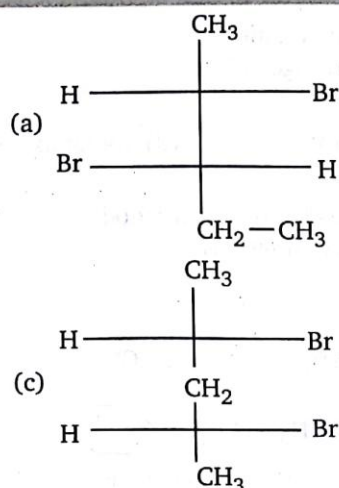
(a)

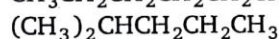
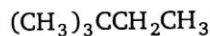
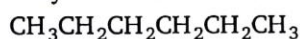
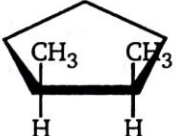
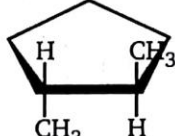
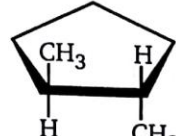
CH3
H — Br
Br — H
CH2—CH3

(b)

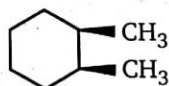
(c)

CH3
H — Br
CH2
H — Br
CH3

(d)

18. Following are the structures of four isomer of hexane. Among the names given below, which correctly identifies the fifth isomer ?

$CH_3CH_2CH_2CH_2CH_2CH_3$ $(CH_3)_3CCH_2CH_3$
$(CH_3)_2CHCH_2CH_2CH_3$ $(CH_3)_2CHCH(CH_3)_2$

(a) 2-Methyl pentane (b) 2-Ethyl butane
(c) 2,3-Dimethyl butane (d) 3-Methyl pentane

19. Which of the following describes the best relationship between the methyl groups in the chair conformation of the substance shown below ?

CH3
CH3

(a) Trans (b) Anti
(c) Gauche (d) Eclipsed

20. Compare the stabilities of the following two compounds (*A*) and (*B*):

A : *cis*-1-ethyl-3-methyl cyclohexane *B* : *trans*-1-ethyl-3-methyl cyclohexane

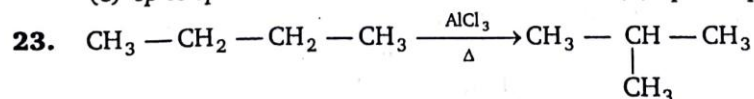
(a) *A* is more stable (b) *B* is more stable
(c) *A* and *B* are of equal stability (d) No comparison can be made

21. Which conformation of ethane has the lowest potential energy ?

(a) Eclipsed (b) Skew
(c) Staggered (d) All will have equal potential energy

22. Ethane is subjected to combustion process. During the combustion the hybrid state of carbon changes from :

(a) sp^2 to sp^3 (b) sp^3 to sp
(c) sp to sp^3 (d) sp^2 to sp^2

23. $CH_3-CH_2-CH_2-CH_3 \xrightarrow[\Delta]{AlCl_3} CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_3$

Above reaction is an example of :

(a) isomerization (b) polymerization
(c) cracking (d) de-hydrogenation

24. Which of the following has highest chlorine content ?
(a) Pyrene (b) DDT (c) Chloral (d) Gammaxene

25. Pure methane can be prepared by :
(a) Wurtz reaction (b) Kolbe electrolysis method
(c) soda-lime de-carboxylation (d) reduction with H_2

26. Calcium carbide + heavy water $\longrightarrow$?
The product of the above reaction is :
(a) C_2H_2 (b) CaD_2 (c) $Ca(OD)_2$ (d) CD_4

27. CH_3-CH_2-(cyclopentyl) Ethyl cyclopentane (I); CH_3-CH_2-(cyclohexyl) Ethyl cyclohexane (II); CH_3-CH_2-(cycloheptyl) Ethyl cycloheptane (III)

Arrange the compounds I, II and III in decreasing order of their heats of combustion:
(a) II > I > III (b) I > II > III
(c) III > II > I (d) III > I > II

28. An alkane (mol. wt. = 86) on bromination gives only two monobromo derivatives (excluding stereoisomers). The alkane is :

(c) $CH_3-CH(CH_3)-CH(CH_3)-CH_3$ (d) $CH_3-C(CH_3)_2-CH_3$

29. Order of the bond strength of C — H bonds involving sp, sp^2 and sp^3 hybridized carbon atoms is :
(a) $sp > sp^2 > sp^3$ (b) $sp^3 > sp^2 > sp$
(c) $sp^2 > sp^3 > sp$ (d) $sp^2 > sp > sp^3$

30.

Among the structures given , select the enantiomers :
(a) I and II (b) I and III
(c) II and III (d) I, II and III

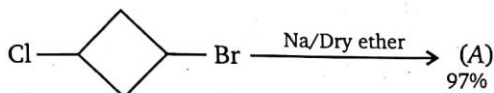
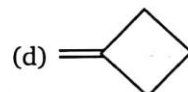
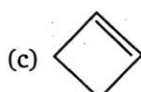
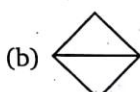
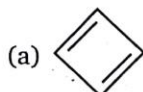
31.

The correct order of reactivity of I, II & III towards addition reactions is :

(a) I > III > II (b) I > II > III (c) III > II > I (d) III > I > II

32.

Product (*A*) of above reaction is :

(a) (b) (c) (d)

33. Which of the following reactants is suitable for preparation of methane and ethane by using one step only ?

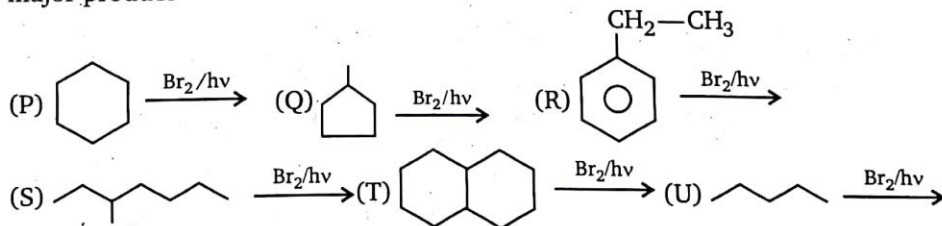
(a) $H_2C = CH_2$ (b) CH_3OH

(c) $CH_3 - Br$ (d) $CH_3 - CH_2 - OH$

34. How many carbon atoms does an alkane (not a cycloalkane) need before it is capable to exist in enantiomeric form ?

(a) 4 (b) 5 (c) 6 (d) 7

35. Among the following free radical bromination reactions, select those in which 2° halide is the major product —

(a) P, Q, R, S (b) P, R, U (c) P, R, S, T (d) P, Q, R, S, T

36. $(A) + Cl_2 \xrightarrow{hv}$ monochloro product

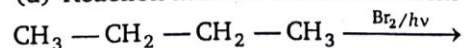
To maximise the yield of monochloro product in the above reaction ?

(a) Cl_2 must be added in excess

(b) Reactant (*A*) must be added in excess

(c) Reaction must be carried out in dark

(d) Reaction must be carried out with equimolar mixture of Cl_2 and *A*

37. $CH_3 - CH_2 - CH_2 - CH_3 \xrightarrow{Br_2/hv}$

Major product in the above reaction is :

(a) Racemic mixture (b) Meso

(c) Diastereomers (d) Constitutional isomers

38. Select the chain propagation steps in the free-radical chlorination of methane.

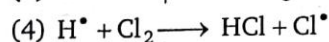
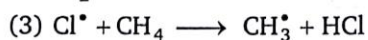
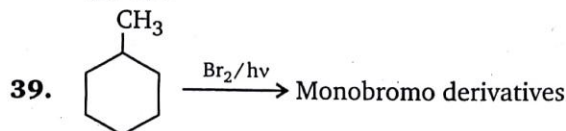
(1) $Cl_2 \longrightarrow 2Cl^{\bullet}$ (2) $Cl^{\bullet} + CH_4 \longrightarrow CH_3Cl + H^{\bullet}$

(3) $Cl^{\bullet} + CH_4 \longrightarrow \dot{C}H_3 + HCl$ (4) $H^{\bullet} + Cl_2 \longrightarrow HCl + Cl^{\bullet}$

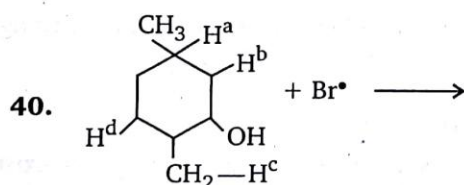
(5) $\dot{C}H_3 + Cl_2 \longrightarrow CH_3Cl + Cl^{\bullet}$

(a) 2, 3, 5 (b) 1, 3, 6

(c) 3, 5 (d) 2, 3, 4

39.

The number of possible monobromo products is (excluding stereoisomers):

(a) 4 (b) 5 (c) 8 (d) 10

40. CH_3, H^a, H^b, H^d, OH, $CH_2—H^c$ + $Br^{\bullet} \longrightarrow$

$Br^{\bullet}$ will abstract which of the hydrogen most readily ?

(a) a (b) b (c) c (d) d

41. Arrange the following compounds in decreasing order of their heats of combustion :

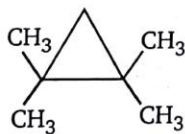
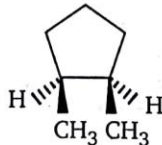
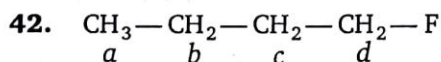
(i)

(ii)

(iii)

(a) (iii) > (ii) > (i) (b) (ii) > (i) > (iii)

(c) (iii) > (i) > (ii) (d) (i) > (ii) > (iii)

42. $\underset{a}{CH_3}—\underset{b}{CH_2}—\underset{c}{CH_2}—\underset{d}{CH_2}—F$

Arrange the hydrogens *a*, *b*, *c*, *d*, in decreasing order of their reactivities towards chlorination:

(a) $a > b > c > d$ (b) $b > c > d > a$

(c) $b > c > a > d$ (d) $c > b > a > d$

43. On catalytic reduction (H_2/Pt) how many alkenes will give *n*-butane ?

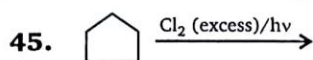
(a) 1 (b) 2

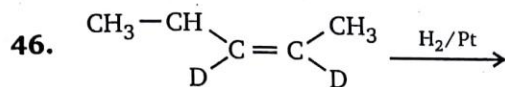
(c) 3 (d) 4

44. On catalytic reduction (H_2/Pt) how many alkenes will give 2-methylbutane ?

(a) 1 (b) 2

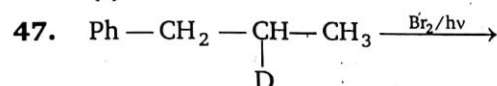
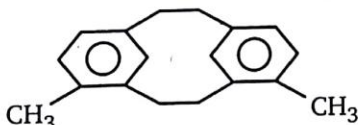
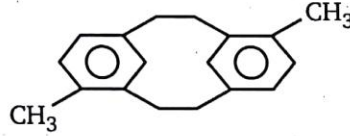
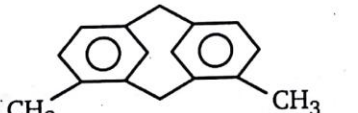
(c) 3 (d) 4

45. (cyclopentane) $\xrightarrow{Cl_2\ (excess)/hv}$

How many dichloro products are formed in the above reaction (including stereoisomers)?

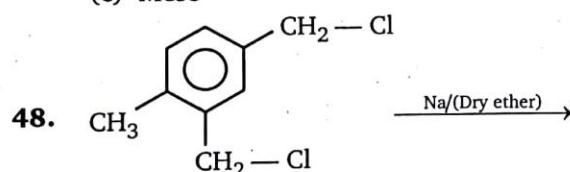
(a) 5 (b) 6
(c) 7 (d) 9

46. $CH_3-CH(D)C=C(CH_3)D \xrightarrow{H_2/Pt}$

Product of the above reaction will be :

(a) Racemic mixture (b) Diastereomers
(c) Meso (d) Constitutional isomers

47. $Ph-CH_2-CH(D)-CH_3 \xrightarrow{Br_2/hv}$

Product of the above reaction will be :

(a) Diastereomers (b) Racemic mixture
(c) Meso (d) Constitutional isomers

48.

Products obtained in above Wurtz reaction is :

(a)

(b)

(c)

(d) Both (a) and (b)

49. Rank the transition states that occur during the following reaction steps in order of increasing stability (least → most stable) :

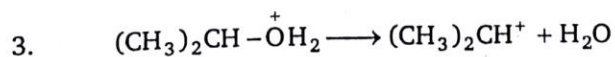
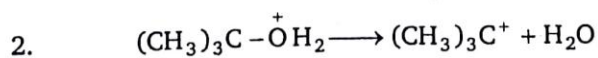
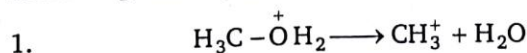
1. $H_3C-\overset{+}{O}H_2 \longrightarrow CH_3^+ + H_2O$

2. $(CH_3)_3C-\overset{+}{O}H_2 \longrightarrow (CH_3)_3C^+ + H_2O$

3. $(CH_3)_2CH-\overset{+}{O}H_2 \longrightarrow (CH_3)_2CH^+ + H_2O$

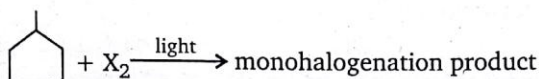
(a) $1 < 2 < 3$ (b) $2 < 3 < 1$
(c) $1 < 3 < 2$ (d) $2 < 1 < 3$

50. Which of the following does not represent major product of that reaction ?

ANSWERS — LEVEL 1															
1.	(d)	**2.**	(b)	**3.**	(b)	**4.**	(b)	**5.**	(b)	**6.**	(d)	**7.**	(b)	**8.**	(a)
9.	(b)	**10.**	(d)	**11.**	(c)	**12.**	(c)	**13.**	(b)	**14.**	(c)	**15.**	(c)	**16.**	(b)
17.	(d)	**18.**	(d)	**19.**	(c)	**20.**	(a)	**21.**	(c)	**22.**	(b)	**23.**	(a)	**24.**	(a)
25.	(c)	**26.**	(c)	**27.**	(c)	**28.**	(c)	**29.**	(a)	**30.**	(c)	**31.**	(b)	**32.**	(b)
33.	(c)	**34.**	(d)	**35.**	(b)	**36.**	(b)	**37.**	(a)	**38.**	(c)	**39.**	(b)	**40.**	(a)
41.	(d)	**42.**	(c)	**43.**	(c)	**44.**	(c)	**45.**	(c)	**46.**	(a)	**47.**	(a)	**48.**	(d)
49.	(c)	**50.**	(d)												

LEVEL-2

1. Comprehension

For the given question (1, 2, 3), consider the following reaction.

$+ X_2 \xrightarrow{\text{light}}$ monohalogenation product

A. Light is involved in which step of the reaction :

(a) Initiation only
(b) Termination only
(c) Propagation only
(d) Propagation and Termination

B. Which halogen will give the best yield of a single monohalogenation product ?

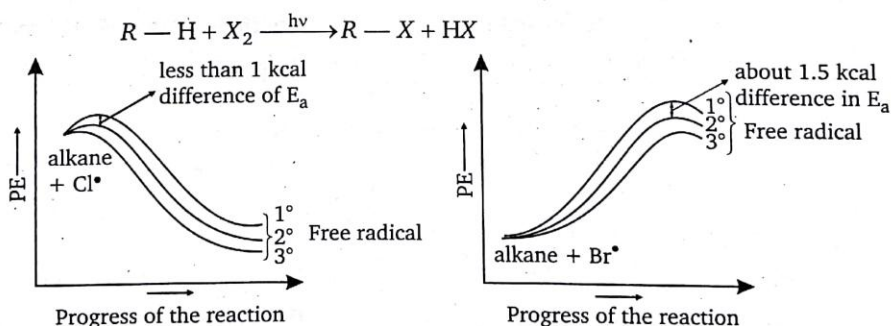
(a) F_2
(b) Cl_2
(c) Br_2
(d) I_2

C. How many monohalo derivatives are possible (excluding stereoisomers) ?

(a) 3
(b) 4
(c) 5
(d) 6

2. Comprehension

Halogenation is a substitution reaction, where halogen replaces one or more hydrogens of hydrocarbon.

$$R-H + X_2 \xrightarrow{h\nu} R-X + HX$$

Chlorination is exothermic and transition state resembles with products

Bromination is endothermic and transition state resembles with products

Chlorine free radical make 1°, 2°, 3° radicals with almost equal ease, whereas bromine free radicals have a clear preference for the formation of tertiary free radicals. So, bromine is less reactive, and more selective whereas chlorine is less selective and more reactive.

The relative rate of abstraction of hydrogen by $Br^\bullet$ is

$$\underset{(1600)}{3°} > \underset{(82)}{2°} > \underset{(1)}{1°}$$

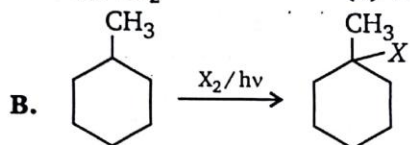
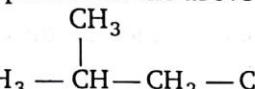
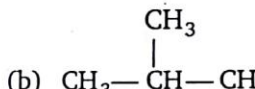
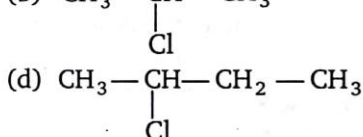
The relative rate of abstraction of hydrogen by $Cl^\bullet$ is :

$$\underset{(5)}{3°} > \underset{(3.8)}{2°} > \underset{(1)}{1°}$$

Consider the above argument and answer A to G :

A. 1-halo-2,3-dimethyl butane will be obtained in better yields, if halogen is :

(a) Br_2 (b) Cl_2 (c) I_2 (d) Can't be predicted

B. Methylcyclohexane $\xrightarrow{X_2/h\nu}$ 1-X-1-methylcyclohexane (CH_3 and X on the same ring carbon)

Above product will obtained in better yield if X is

(a) Cl_2 (b) I_2 (c) Br_2 (d) Can't be predicted

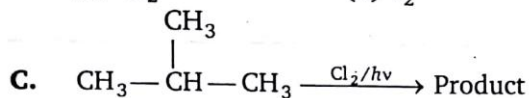
C. $CH_3-\underset{|}{\overset{CH_3}{CH}}-CH_3 \xrightarrow{Cl_2/h\nu}$ Product

Major product in the above reaction is :

(a) $CH_3-CH(CH_3)-CH_2-Cl$

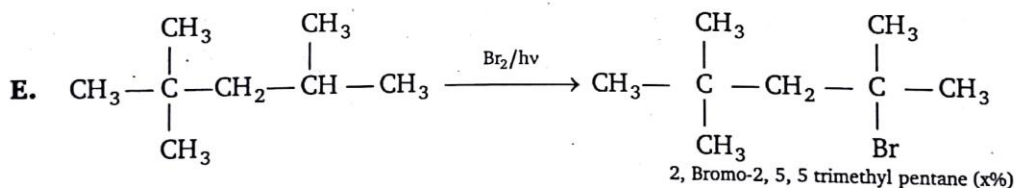
(b) $CH_3-C(CH_3)(Cl)-CH_3$

(c) $CH_3-CH_2-CH_2-Cl$

(d) $CH_3-CH(Cl)-CH_2-CH_3$

D. Which of the following will give five monochloro products, when allowed to react with Cl_2 in presence of sun light (excluding stereoisomers) ?

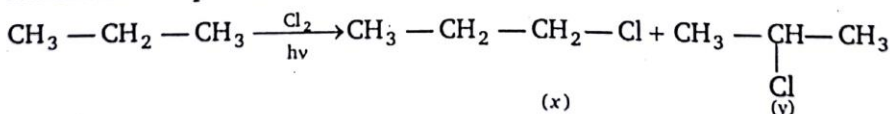
(a) n-pentane (b) Iso-pentane (c) 2-methyl-pentane (d) 3-methyl pentane

E. $CH_3-C(CH_3)_2-CH_2-CH(CH_3)-CH_3 \xrightarrow{Br_2/h\nu} CH_3-C(CH_3)_2-CH_2-C(CH_3)(Br)-CH_3$

2, Bromo-2, 5, 5 trimethyl pentane (x%)

What is the value of x (% yield of product)?

(a) 18 % (b) 82 % (c) 90 % (d) 60 %

F. What would be the product ratio x/y in the chlorination of propane if all the hydrogen were abstracted at equal rate ?

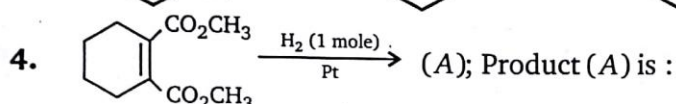
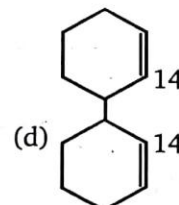
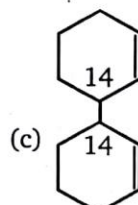
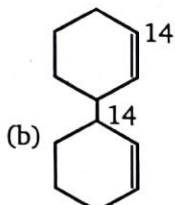
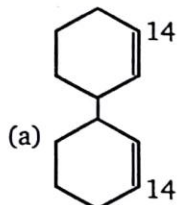
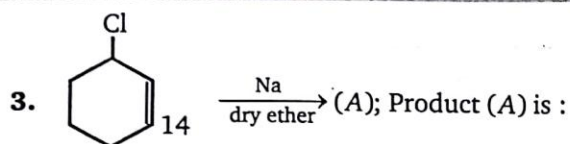
$$CH_3-CH_2-CH_3 \xrightarrow[h\nu]{Cl_2} \underset{(x)}{CH_3-CH_2-CH_2-Cl} + \underset{(y)}{CH_3-CH(Cl)-CH_3}$$

(a) $\frac{1}{3}$ (b) $\frac{3}{1}$ (c) $\frac{9}{1}$ (d) $\frac{1}{9}$

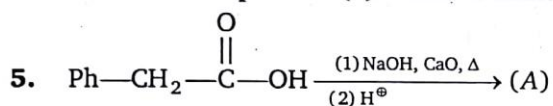
G. How many dichloro products (including stereoisomers) will be formed when R-2-chloropentane reacts with Cl_2 in presence of UV radiation ?

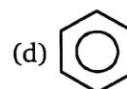
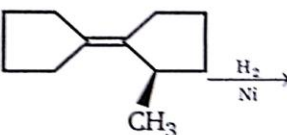
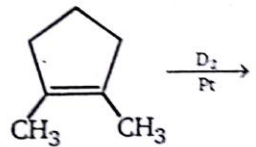
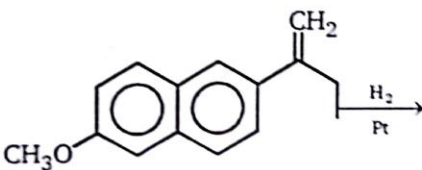
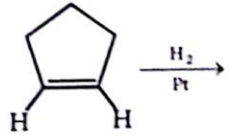
(a) 5 (b) 6 (c) 7 (d) 8

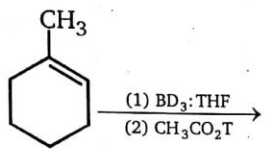
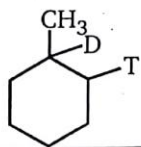
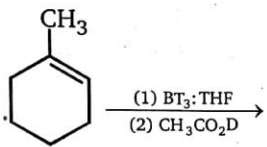
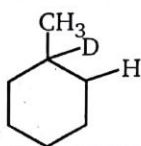
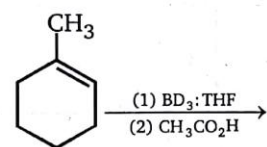
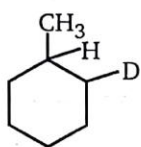
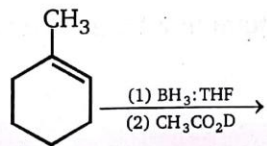
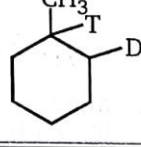
3. (Cyclohexene with Cl, labelled 14) $\xrightarrow[\text{dry ether}]{\text{Na}}$ (A); Product (A) is :

(a) (b) (c) (d) [bicyclohexenyl structures labelled 14]

4. (Cyclohexene with two CO_2CH_3 groups) $\xrightarrow[\text{Pt}]{H_2 \text{ (1 mole)}}$ (A); Product (A) is :

(a) Meso compound (b) Racemic mixture (c) Diastereomers (d) Optically active

5. $Ph—CH_2—\overset{O}{\overset{||}{C}}—OH \xrightarrow[(2)\ H^{\oplus}]{(1)\ NaOH,\ CaO,\ \Delta} (A)$

Product (A) is :

(a) $Ph—CO_2H$ (b) $Ph—CH_2—OH$ (c) $Ph—CH_3$ (d) (benzene)

6. **Match the column I with column II and with column III.**

	Column (I)		Column (II)		Column (III)
	Compound		Mono-chloro products (excluding stereoisomerism)		Monochloro products (including stereoisomerism)
(a)	(bicyclo[2.2.0]hexane)	**(p)**	1	**(w)**	1
(b)	$CH_3—CH(CH_3)—CH_2—CH_3$	**(q)**	2	**(x)**	3
(c)	$CH_3—C(CH_3)_2—C(CH_3)_2—CH_3$	**(r)**	3	**(y)**	5
(d)	$CH_3—CH_2—CH_2—CH_3$	**(s)**	4	**(z)**	6

7.

A.	R-2-chloropentane $\xrightarrow[h\nu]{Cl_2}$ Optically active di-chloro products (P)
B.	☐ $\xrightarrow[h\nu]{Cl_2}$ Optically active dichloro products (Q)
C.	R-2-chlorobutane $\xrightarrow[h\nu]{Cl_2}$ Optically active di-chloroproducts (R)

Sum $P + Q + R$ is :

8. Match the column I and II.

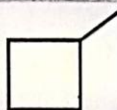
	Column (I)		Column (II)
	Reaction		**Type of Reaction**
(a)	CH_3 $\xrightarrow[Ni]{H_2}$	(p)	Meso compound
(b)	CH_3 CH_3 $\xrightarrow[Pt]{D_2}$	(q)	Diastereomers
(c)	CH_2 CH_3O $\xrightarrow[Pt]{H_2}$	(r)	Racemic
(d)	H H $\xrightarrow[Pt]{H_2}$	(s)	Optically inactive due to absence of chiral center

9. Match the column :

	Column (I) Reaction		Column (II) Product
(a)	CH_3 $\xrightarrow[(2)\ CH_3CO_2T]{(1)\ BD_3:THF}$	(p)	CH_3, D, T
(b)	CH_3 $\xrightarrow[(2)\ CH_3CO_2D]{(1)\ BT_3:THF}$	(q)	CH_3, D, H
(c)	CH_3 $\xrightarrow[(2)\ CH_3CO_2H]{(1)\ BD_3:THF}$	(r)	CH_3, H, D
(d)	CH_3 $\xrightarrow[(2)\ CH_3CO_2D]{(1)\ BH_3:THF}$	(s)	CH_3, T, D

10. How many distinct monochlorinated products, (including stereoisomers) may be obtained when the alkane shown below is heated in the presence of Cl_2 ?

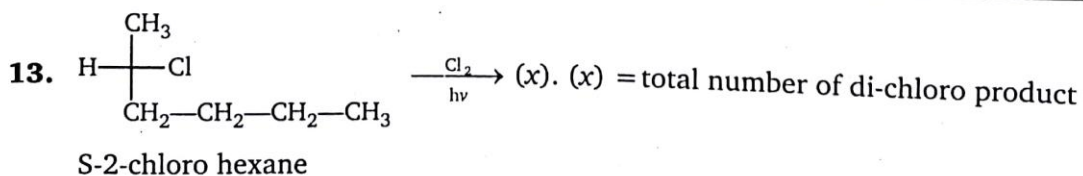
(a) 1 (b) 2 (c) 3 (d) 4 (e) 6

11. How many distinct monochlorinated products, (including stereoisomers) may be obtained when the alkane shown below is heated in the presence of Cl_2 ?

(a) 2 (b) 4 (c) 5 (d) 6 (e) 8

12. Match the column :

	Column (I)		Column (II)
	Wurtz reaction		**Number of dimerization product**
(a)	$CH_3-Cl \xrightarrow[\text{dry ether}]{Na}$	**(p)**	5
(b)	$CH_3-Cl+CH_3-CH_2-Cl \xrightarrow[\text{dry ether}]{Na}$	**(q)**	6
(c)	$CH_3-Cl+CH_3-CH_2-Cl$ $+CH_3-CH_2-CH_2-Cl \xrightarrow[\text{dry ether}]{Na}$	**(r)**	3
(d)	$H_2C=CH-CH=CH-CH_2-Cl$ $+CH_3-CH_2-Cl \xrightarrow[\text{dry ether}]{Na}$	**(s)**	1

13. $H-\overset{\displaystyle CH_3}{\underset{\displaystyle CH_2-CH_2-CH_2-CH_3}{C}}-Cl \xrightarrow[h\nu]{Cl_2} (x)$. (x) = total number of di-chloro product

S-2-chloro hexane

ANSWERS — LEVEL 2

1. A – a; B – c; C – b
2. A – b; B – c; C – a; D – c; E – c; F – b; G – c
3. a, b, c
4. a
5. c
6. a – q – x; b – s – z; c – p – w; d – q – x
7. $P + Q + R = 10$
8. a – q; b – p; c – r; d – s
9. a – p; b – s; c – q; d – r
10. a
11. e
12. a – s; b – r; c – p; d – q
13. 9

4B HYDROCARBONS (ALKENES)

LEVEL-1

1. (R)-3-bromocyclopentene (shown below) reacts with Br_2/CCl_4 to form two products, Y and Z, Y is not optically active (does not rotate plane-polarized light). What is the structure of Y ?

$\xrightarrow{Br_2/CCl_4} Y + Z$

(a) (b) (c) (d) (e)

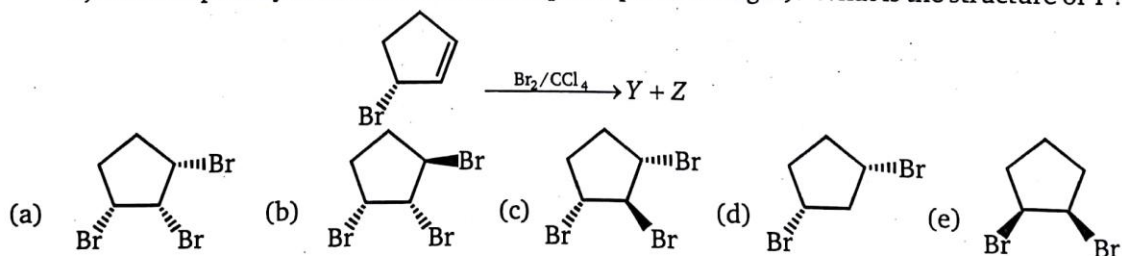
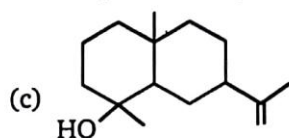
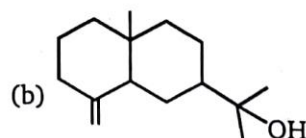
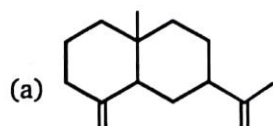
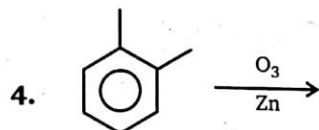
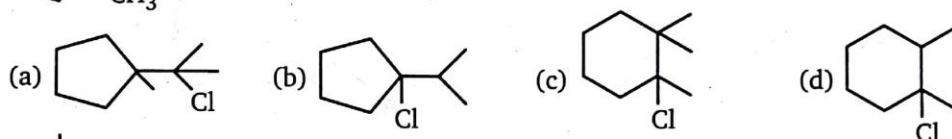
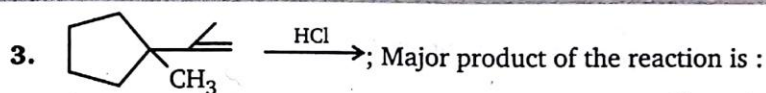
2. $A \xrightarrow{2HCl}$. Reactant (*A*) can be:

(a) (b)

(c) (d) All of these

3. $\xrightarrow{HCl}$; Major product of the reaction is :

(a) (b) (c) (d)

4. $\xrightarrow[Zn]{O_3}$

Which of the following products cannot be obtained in ozonolysis of *o*-xylene?

(a) $\begin{matrix} CHO \\ | \\ CHO \end{matrix}$

(b) $CH_3-\overset{O}{\overset{\|}{C}}-\overset{O}{\overset{\|}{C}}-H$

(c) $CH_3-\overset{O}{\overset{\|}{C}}-\overset{O}{\overset{\|}{C}}-CH_3$

(d) $CH_3-\overset{O}{\overset{\|}{C}}-\overset{O}{\overset{\|}{C}}-CHO$

5. $\xrightarrow{H^+}$ Major product of the reaction is :

(a)

(b) HO

(c)

(d)

6. $\begin{matrix} CH_2-CO_2K \\ | \\ CH_2-CO_2K \end{matrix} \xrightarrow{\text{electrolysis}} \underset{\text{(major)}}{(A)}$ (Kolbe electrolysis method)

Product (*A*) of the reaction is :

(a) CH_3-CH_3

(b) $CH_2=CH_2$

(c) $CH_3-CH=CH_2$

(d) none of these

7. $\xrightarrow[Zn]{O_3} A \xrightarrow[\text{Or } LiAlH_4]{H_2/Ni} B \xrightarrow[\Delta]{H^+} (C)$; Product (*C*) of the reaction is :

(a)

(b)

(c)

(d)

8. OH $\xrightarrow[CH_2Cl_2]{Br_2}$ W. Product W is :

(a) Br, OH (b) Br, Br, OH

(c) O, Br (d) Br, OH

9. The reaction of propene with H_3O^+ will proceed with which of the following intermediates ?

(a) $CH_3-CH_2-\overset{\oplus OH_2}{\overset{|}{C}H_2}$ (b) $CH_3-\overset{\oplus}{C}H-\overset{OH}{\overset{|}{C}H_2}$

(c) $CH_3-\overset{\oplus OH_2}{\overset{|}{C}H}-CH_3$ (d) $CH_3-\overset{OH}{\overset{|}{C}H}-CH_3$

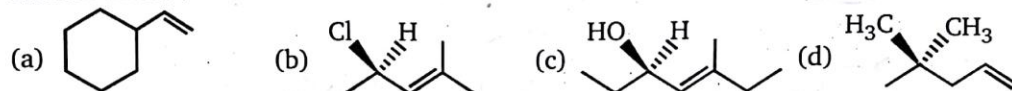
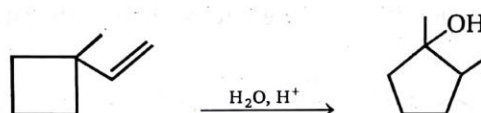
10. Which of the following bromides is the major product of the reaction shown below, assuming that there are no carbocation rearrangement ?

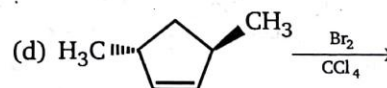
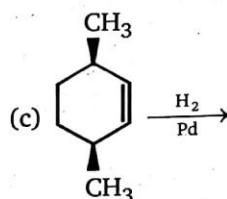
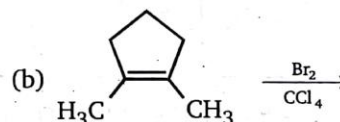
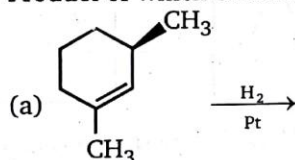
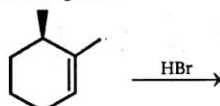
11. Which of the following reactions results in the formation of a pair of diastereomers ?

(a) H_3C, CH_3, CH $\xrightarrow{HBr}$ (b) H_3C, H $\xrightarrow{HBr}$

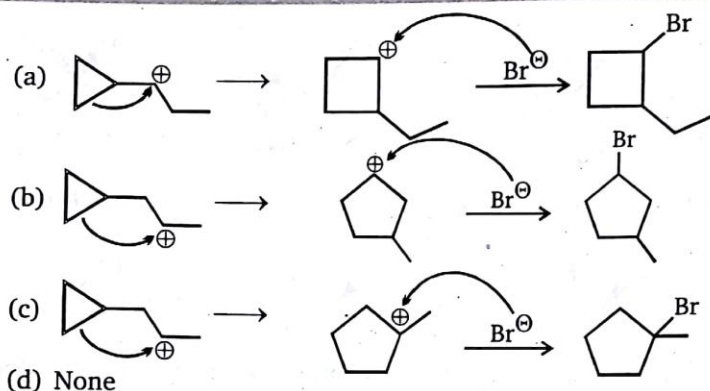
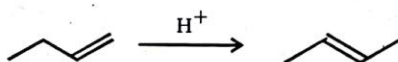
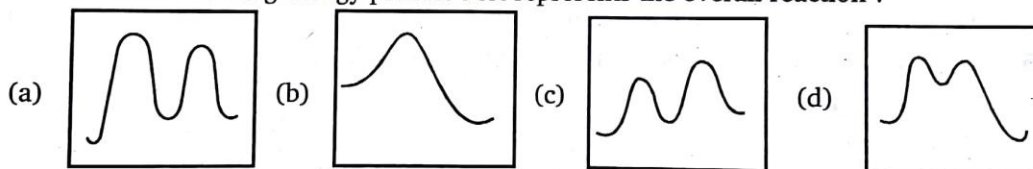
(c) H_3C, H $\xrightarrow[ROOR,\ UV]{HBr}$ (d) H_3C, H $\xrightarrow[2.\ H_2O_2,\ OH^-,\ H_2O]{1.\ BH_3,\ THF}$

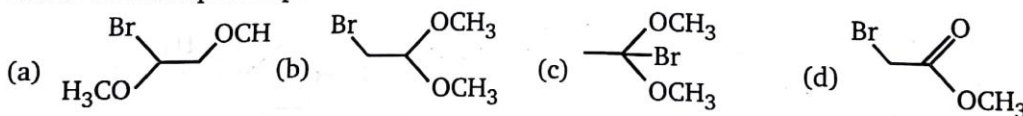
12. What is a likely product of the reaction shown ?

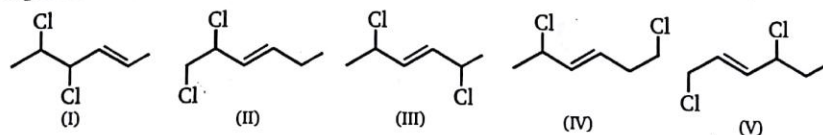
13. Which of the following, when undergoing addition of HBr, will form ONLY a pair of diastereomers ?

14. How many transition states and intermediates will be formed during the course of following reaction ?

(a) 3 transition states and 3 intermediates (b) 4 transition states and 3 intermediates
(c) 3 transition states and 2 intermediates (d) 5 transition states and 4 intermediates

15. Product of which of the following reactions, is racemic mixture ?

16. The product(s) of the following reaction can best be described as :

(a) a racemic mixture (b) a single enantiomer
(c) a pair of diasteriomers (d) an achiral molecule

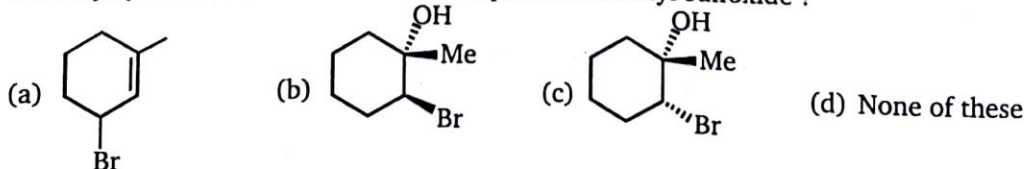
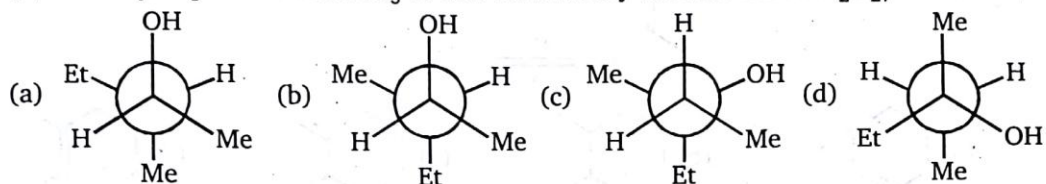
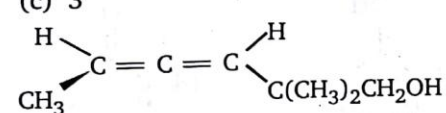
17. Taking into account the stability of various carbocations and, as well as the rules governing mechanisms of carbocation rearrangements, which reaction is most likely to occur during the given reaction ?

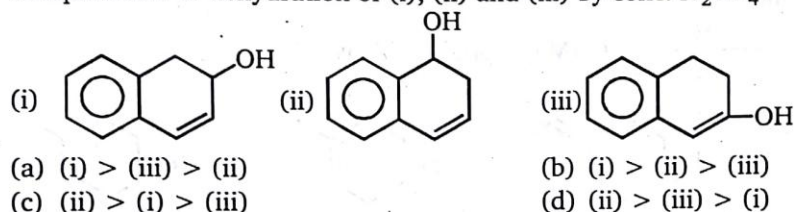
(d) None

18. Consider the following reaction in which the intermediate carbocation loses H^+ to give the final product ?

Which of the following energy profiles best represents the overall reaction ?

19. Methyl vinyl ether, $H_2C=CH-OCH_3$, reacts with Br_2/CH_3OH. If methanol is reacting as water would, and if this reaction follows a typical mechanism of electrophilic addition, what would be the expected product ?

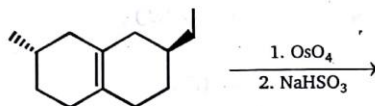
(a) Br, OCH, H_3CO (b) Br, OCH_3, OCH_3 (c) OCH_3, Br, OCH_3 (d) Br, O, OCH_3

20. 2, 4-hexadiyne (C_6H_6) is allowed to react with Li in NH_3(liq). The product obtained is treated with 1 equivalent of Cl_2 in CCl_4. Which of the following constitutional isomers are possible products ?

Cl, Cl (I)   Cl, Cl (II)   Cl, Cl (III)   Cl, Cl (IV)   Cl, Cl (V)

(a) I and II
(b) II and III
(c) I and V
(d) I and III

21. Which of the following is the best stereochemical representation when reaction between 1-methylcyclohexene and NBS react in aqueous dimethyl sulfoxide ?

(d) None of these

22. Which of the following is among the major products of the reaction of (E)-3-methyl-2-pentene with BH_3 in THF followed by the addition of H_2O_2/HO^-?

23. Compare rate of dehydration of (i), (ii) and (iii) by conc. H_2SO_4.

(a) (i) > (iii) > (ii)
(b) (i) > (ii) > (iii)
(c) (ii) > (i) > (iii)
(d) (ii) > (iii) > (i)

24. How many products will be formed in this reaction ?

(a) 10
(b) 2
(c) 3
(d) 4

25. $\underset{CH_3}{\overset{H}{>}}C = C = C\underset{C(CH_3)_2CH_2OH}{\overset{H}{<}} \xrightarrow[CCl_4]{Br_2} (A)$. Product (*A*) of the reaction is:

26. $CH_3-\underset{CH_3}{\overset{CH_3}{\overset{|}{\underset{|}{C}}}}H + H_2C = CH_2 \xrightarrow[2\text{-}5°C]{HF} (A)$; (*A*) is:

(a)
(b)
(c) H
(d) $CH_3-\underset{CH_3}{\underset{|}{C}}H-CH_2-CH = CH_2$

27. Predict the product (A) of the following reaction

28. OH $\xrightarrow[\Delta]{H^+}$ (A) (Major) Major-product (A) is:

(a) (b) (c) (d)

29. Di-imide (N_2H_4) is used to reduce double bond of:

(a) $-\overset{|}{C}=O$ (b) $-C\equiv N$ (c) $-NO_2$ (d) $-CH=CH-$

30. $\xrightarrow{HCl}(A)\xrightarrow[H_2O]{NaHCO_3}(B)\ C_5H_8O \xrightarrow{Na_2Cr_2O_7}(C)$

End product of the reaction is :

31. $\xrightarrow[CCl_4]{HBr}$ A (Major)

Product (A) is :

32.

Compound (A) is :

(a) (b) (c) (d)

33. (cyclohex-2-en-1-ol) $\xrightarrow{OsO_4}$ $\underset{12\ :\ 1}{X + Y}$

Product (X) will be :

(a) OH, OH, OH triol (b) OH, OH, OH triol (c) OH epoxide (d) epoxide

34. $C_6H_5-CH=CH-C_6H_5 \xrightarrow[CCl_4]{Br_2} A \xrightarrow{2NaNH_2} B \xrightarrow[Pd/CaCO_3]{H_2} C$

Product (C) is

(a) $\underset{H}{\overset{Ph}{>}}C=C\underset{Ph}{\overset{H}{<}}$ (b) $\underset{H}{\overset{Ph}{>}}C=C\underset{H}{\overset{Ph}{<}}$ (c) $\underset{Ph}{\overset{Ph}{>}}C=CH_2$ (d) $Ph-C\equiv C-Ph$

35. $\xrightarrow[\text{Ethanol}]{\text{MMPP(one-equivalent)}}$ $\underset{74\%}{X}$

MMPP ⟶ Magnesium mono peroxy phthalate.

Product (X) is :

(a) O (b) O

(c) HO, HO (d) OH, OH

36. OMe, O $\xrightarrow{\text{MCPBA}}$ $\underset{75\%}{P}$; Product (P) is :

(a) OMe, O, O (b) OMe, O, O

(c) OMe ... O O (d) None of these

37. Cyclic osmate ester complexed with pyridine $\xrightarrow[\text{Mannitol/Water}]{\text{KOH}}$ A; Product (A) is :

(a) HO, CH_3, CH_3, OH

(b) CH_3, CH_3, OH, OH

(c)

(d) O, CH_3, CH_3

38. CH_3 (toluene) + $CBrCl_3 \xrightarrow{h\nu}$ (A) (no ring substitution)

Product (A) is :

(a) $Ph-CH_2-Cl$

(b) $Ph-CH_2-Br$

(c) $Ph-CH_2-CCl_3$

(d) $Ph-CH_2-CBrCl_2$

39. $\xrightarrow{\text{MCPBA}}$ (A) ; MCPBA $\longrightarrow$ metachloroperbenzoic acid

Product (A) of the above reaction is :

(a) O

(b) O

(c) OH

(d) HO

40. The major product of the following reaction sequence is :

41. Which one of the following compounds gives acetone $(CH_3)_2C=O$ as one of the product of its ozonolysis ?

42. Addition of HCl to 3, 3-dimethyl-1-butene yields two products, one of which has a rearranged carbon skeleton. Among the following carbocations, select the possible intermediates in that reaction ?

$(CH_3)_3C\overset{+}{C}HCH_2Cl$	$(CH_3)_3C\overset{+}{C}HCH_3$	$(CH_3)_2C\overset{+}{C}(CH_3)_2$ (with Cl on C)	$(CH_3)_2\overset{+}{C}CH(CH_3)_2$
1	2	3	4

(a) 1, 2 (b) 1, 3 (c) 1, 4 (d) 2, 3
(e) 2, 4

43. Conversion of cyclohexene to cyclohexanol can be conveniently achieved by :
(a) $NaOH + H_2O$
(b) $Br_2 - H_2O$
(c) hydroboration, oxidation
(d) hydroboration hydrolysis

44. *Trans*-cyclohexane-1,2-diol can be obtained by the reaction of cyclohexene with :
(a) $KMnO_4$
(b) OsO_4
(c) peroxy formic acid /H_3O^+
(d) SeO_2

45. Bromination of (E)-2-butenedioic acid gives
(a) (2R, 3S)-2, 3-dibromosuccinic acid
(b) (2R, 3R)-2, 3-dibromosuccinic acid
(c) a mixture of (2R, 3R) and (2S, 3S)-2, 3-dibromosuccinic acid
(d) (2S, 3S)-2, 3-dibromosuccinic acid

46. The major product formed during the reaction of 1-methyl cyclopentene with CH_3CO_3H is

47.
$$\begin{matrix} CH-CO_2H \\ \| \\ CH-CO_2H \end{matrix} \xrightarrow[\text{(two mole)}]{NaOH} (A) \xrightarrow{\text{electrolysis}} (B)$$
; Product (*B*) of the reaction is :

(a) CH_3-CH_3
(b) $H_2C=CH_2$
(c) $H-C\equiv C-H$
(d) $CH_2=CH-CH=CH_2$

48.

49. Cyclohexene $\xrightarrow[\text{(2) } NaBH_4,\ HO^-]{\text{(1) } (CF_3CO_2)_2Hg,\ CH_3CH_2OH}$ (*P*) (100%) ; Product (*P*) is :

(a) OH (b) OCH_2CH_3 (c) OH, OH (d) OEt, OEt

50. What is the major product expected from the following reaction ?

51. $CH_3-CH=CH_2 \xrightarrow[\text{(low conc.)}]{Br_2/h\nu} (A)$; Product (*A*) of the reaction is :

(a) $CH_3-\underset{\underset{Br}{|}}{CH}-CH_2-Br$ (b) $H_2C=CH-CH_2-Br$

(c) $CH_3-\underset{\underset{Br}{|}}{C}=CH_2$ (d) $Br-CH_2-CH_2-CH_2-Br$

52. Et – CH – C(=O) – O – CH(C(CH$_3$)=CH$_2$) – CH$_2$ (ring) $\xrightarrow{A}$ Et – CH – C(=O) – O – CH(C(CH$_3$)=O) – CH$_2$ (ring) ; Reagent (*A*) in the reaction is :

(a) $O_3/Zn(H_2O)$ (b) HIO_4 (c) CrO_3 (d) Cold dil. $KMnO_4$

53. $\xrightarrow[\text{2. NaHSO}_3]{\text{1. OsO}_4}$ Product of the reaction is:

(a) (b) (c) (d)

54. Which compound is a possible product from addition of Br_2 to 1-butene ?

(a) (b) (c) (d)

55. Addition of Br_2 to *cis*-2-butene would give a product which is:

(a) achiral (b) racemic
(c) meso (d) optically active

56. Addition of Br_2 to *trans*-2-butene would give a product which is:

(a) achiral (b) racemic (c) meso (d) optically active

57. Addition of OsO_4 to cyclopentene would give a product which is:

(a) achiral (b) racemic (c) meso (d) optically active

58. Addition of BH_3 followed by H_2O_2 to *trans*-2-butene would give a product which is:

(a) achiral (b) racemic (c) meso (d) optically active

59.

; Reagent A may be :

(a) H_2O/H^+ (b) $BH_3.THF/H_2O_2-OH^-$
(c) $Hg(OCOCH_3)_2.H_2O/NaBH_4.NaOH$ (d) All are possible

60. The major product of the following reaction is :

$$CH_3-CH=CH_2+HBr\xrightarrow{(C_6H_5CO)_2O_2}$$

(a) $CH_3-CH_2-CH_2-Br$ (b) $CH_3CH(Br)-CH_3$
(c) $BrCH_2-CH=CH_2$ (d) Br

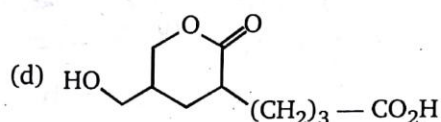
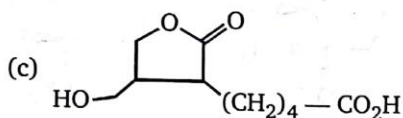
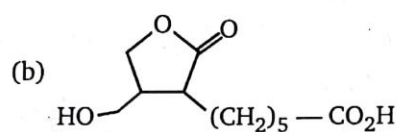
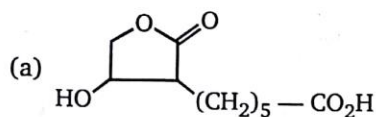
61.

Identify (B) :

(a) HO ... $(CH_2)_5-CO_2H$

(b) HO ... $(CH_2)_5-CO_2H$

(c) HO ... $(CH_2)_4-CO_2H$

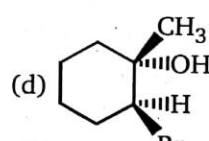
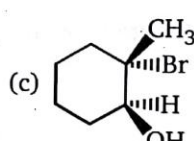
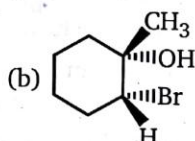
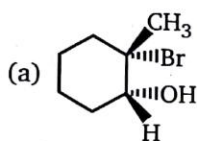
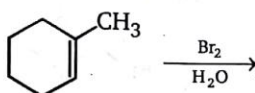
(d) HO ... $(CH_2)_3-CO_2H$

62. Which of the following is a major product of the reaction shown below?

CH_3 $\xrightarrow[H_2O]{Br_2}$

(a) CH_3, Br, OH, H

(b) CH_3, OH, Br, H

(c) CH_3, Br, H, OH

(d) CH_3, OH, H, Br

63. In methyl alcohol solution, bromine reacts with ethylene (ethene) to yield $BrCH_2CH_2OCH_3$ in addition to 1, 2-dibromoethane because

(a) the methyl alcohol solvates the bromine

(b) the ion formed initially may react with Br^- or CH_3OH

(c) this is a free radical reaction

(d) the reaction follows Markovnikov's rule

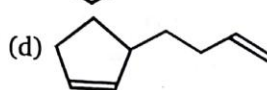
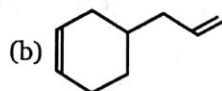
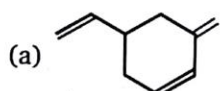
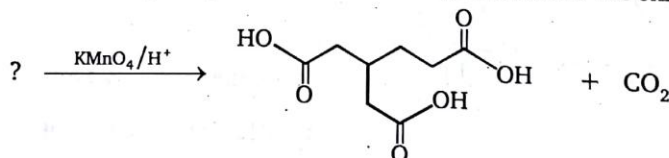
64. Which of the following compound was the starting material for the oxidation shown below?

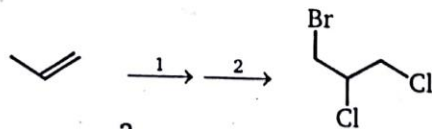
? $\xrightarrow{KMnO_4/H^+}$ HO ... OH ... OH $+ CO_2$

(a)

(b)

(c)

(d)

65. Which series of reactions will achieve the following transformation ?

$\xrightarrow{1}\xrightarrow{2}$ Br ... Cl ... Cl

	1	2
(a)	Cl_2/CCl_4	Br_2
(b)	HBr	Cl_2/CCl_4
(c)	Cl_2/CCl_4	NBS/hν
(d)	NBS/hν	Cl_2/CCl_4

66. Taking into account the stability of various cycloalkanes and carbocations, as well as the rules governing mechanisms of carbocation rearrangements, what is the most likely product of this reaction ?

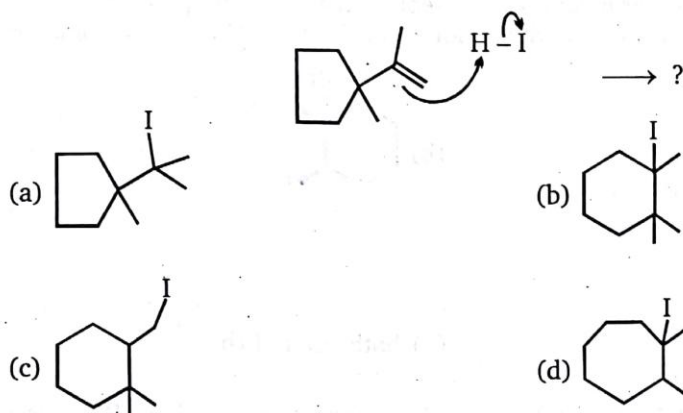
H – I

⟶ ?

(a)

(b)

(c)

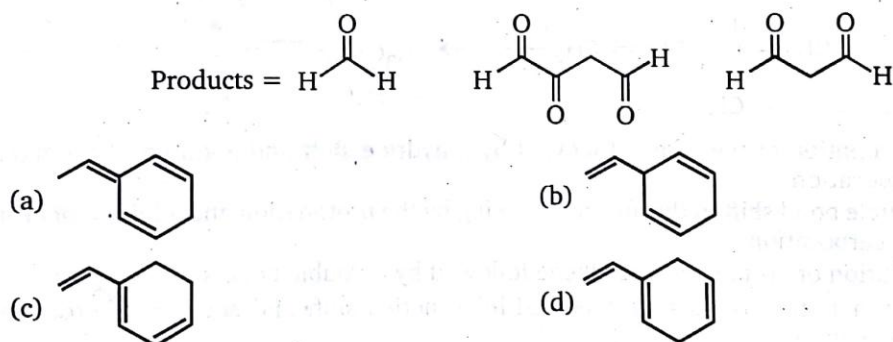
(d)

67. A triene is treated with ozone followed by zinc in acetic acid to give the following three products. What is the structure of the triene ?

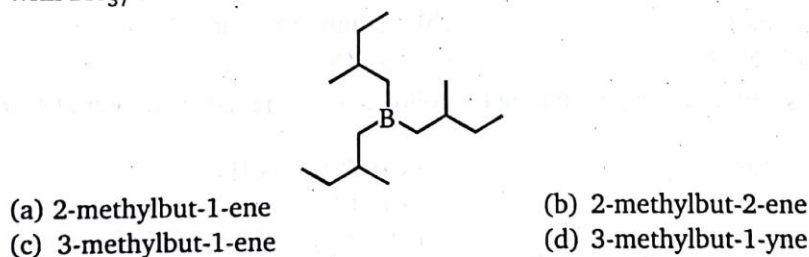
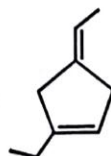
Products =

(a)

(b)

(c)

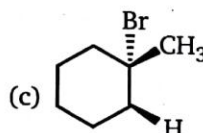
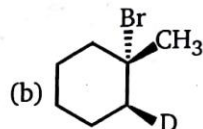
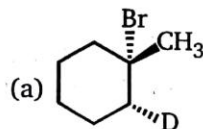
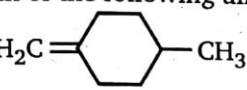
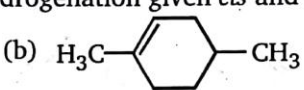
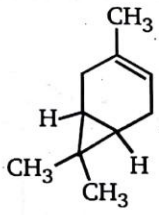
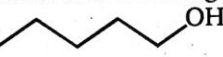
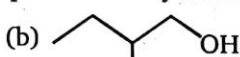
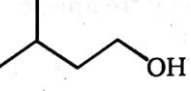
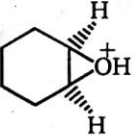
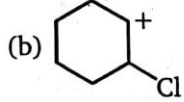
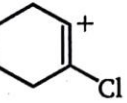
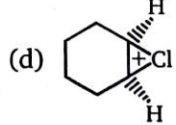
(d)

68. Which of the following compound would yield trialkylborane shown below when treated with BH_3/THF ?

(a) 2-methylbut-1-ene
(b) 2-methylbut-2-ene
(c) 3-methylbut-1-ene
(d) 3-methylbut-1-yne

69. If the following compound is treated with Pd/C in excess of hydrogen gas, how many stereoisomers of the product will be obtained ?

(a) 1 (b) 2
(c) 3 (d) 4

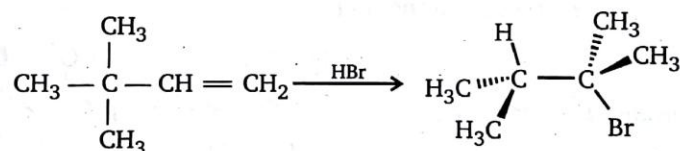
70. Which is the most precise designation of stereochemistry for the products formed in the electrophilic addition of DBr to 1-methylcyclohexene ? (D = ^{2}H, an isotope of hydrogen)

(a) [structure: cyclohexane with Br (hashed) and CH_3 (wedged) on C-1, D (hashed) on C-2]

(b) [structure: cyclohexane with Br (hashed) and CH_3 (wedged) on C-1, D (wedged) on C-2]

(c) [structure: cyclohexane with Br (hashed) and CH_3 (wedged) on C-1, H (wedged) on C-2]

(d) both (a) and (b)

71. Consider the addition of HBr to 3,3-Dimethyl-1-butene shown below. What is the best mechanistic explanation for the formation of the observed product ?

$$CH_3-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-CH=CH_2 \xrightarrow{HBr} (H_3C)_2CH-C(CH_3)_2Br$$

(a) Protonation of the alkene followed by a hydride shift and addition of bromide to the carbocation
(b) Double bond shift in the alkene following by the protonation and addition of bromide to the carbocation
(c) Addition of bromide to the alkene followed by a double bond shift and protonation
(d) Protonation of the alkene followed by a methyl shift and addition of bromide to the carbocation

72. Propene $CH_3CH=CH_2$ can be converted into 1-propanol by oxidation. Indicate which sets of reagents amongst the following is ideal to effect the above conversion ?
(a) $KMnO_4$ (alkaline) (b) Osmium tetroxide (OsO_4/CH_2Cl_2)
(c) B_2H_6 and alk. H_2O_2 (d) O_3/Zn

73. Which is the most suitable reagent among the following distinguish compound (3) from the others ?
(1) $CH_3C\equiv C-CH_3$ (2) $CH_3CH_2-CH_2-CH_3$
(3) $CH_3CH_2C\equiv CH$ (4) $CH_3CH=CH_2$
(a) Bromine in carbon tetrachloride (b) Bromine in acetic acid solution
(c) Alk. $KMnO_4$ (d) Ammonical silver nitrate

74. The principal organic product formed in the reaction given below is :
$CH_2=CH(CH_2)_8COOH + HBr \xrightarrow{peroxide}$ ....
(a) $CH_3-CHBr(CH_2)_8COOH$ (b) $CH_2=CH(CH_2)_8COBr$
(c) $CH_2BrCH_2(CH_2)_8COOH$ (d) $CH_2=CH(CH_2)_7CHBrCOOH$

75. When 2-butyne is treated with $Pd - BaSO_4$; the product formed will be :

(a) *cis*-2-butene (b) *trans*-2-butene (c) 1-butene (d) 2-hydroxy butane

76. In the reaction, $CH_3C \equiv C - CH_3 \xrightarrow[\text{(ii) } Zn/H_2O]{\text{(i) } X} CH_3 - \underset{\underset{O}{\|}}{C} - \underset{\underset{O}{\|}}{C} - CH_3$, X is :

(a) HNO_3 (b) O_2 (c) O_3 (d) $KMnO_4$

77. Which of the following alkene on catalytic hydrogenation given *cis* and *trans*-isomer ?

(a) H_2C=(cyclohexane ring)–CH_3 (b) H_3C–(cyclohexene ring)–CH_3

(c)

(d) all of these

78. In the reaction of hydrogen bromide with an alkene (in the absence of peroxides), the first step of the reaction is the .... to the alkene.

(a) fast addition of an electrophilic (b) slow addition of an electrophile
(c) fast addition of a nucleophilic (d) slow addition of a nucleophile

79. Which of the following alcohols cannot be prepared from hydration of an alkene ?

(a) OH (b) OH

(c) OH (d) OH

80. Which of the species shown below is the most stable form of the intermediate in the electrophilic addition of Cl_2 in water to cyclohexene to form a halohydrin ?

(a) H, $\overset{+}{O}H$, H (b) +, Cl

(c) +, Cl (d) H, +Cl, H

81. The reaction, $(CH_3)_2C = CH_2 + Br^\bullet \longrightarrow (CH_3)_2\dot{C} - CH_2Br$

is an example of a/an .... step in a radical chain reaction.

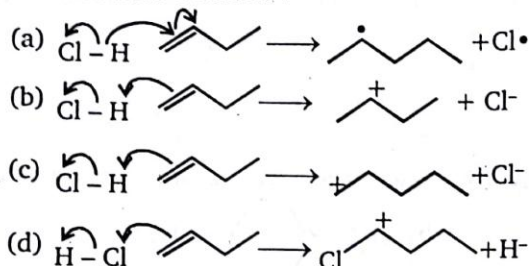
(a) initiation (b) termination
(c) propagation (d) heterolytic cleavage

82. Which of the following most accurately describes the first step in the reaction of hydrogen chloride with 1-butene ?

(a) Cl – H → + Cl•

(b) Cl – H → + Cl^-

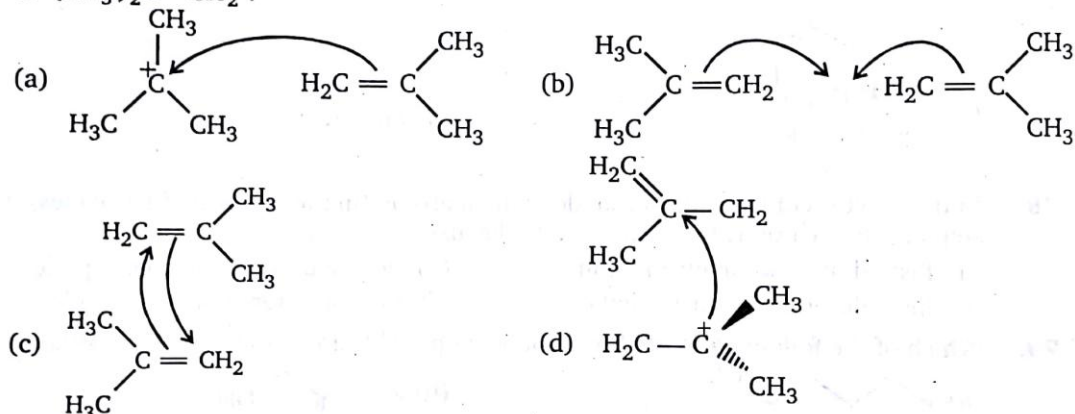
(c) Cl – H → + Cl^-

(d) H – Cl → Cl + H^-

83. Which of the following best describes the flow of electrons in the acid-catalyzed dimerization of $(CH_3)_2C=CH_2$?

(a) $(CH_3)_3C^+$ ← $H_2C=C(CH_3)_2$

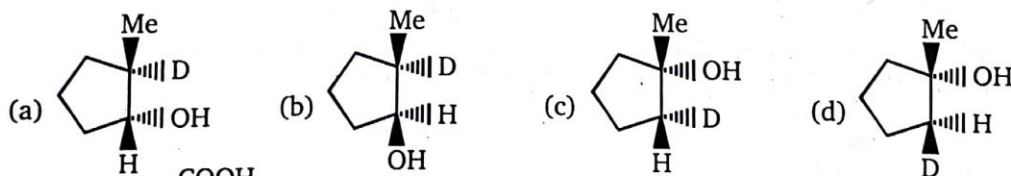
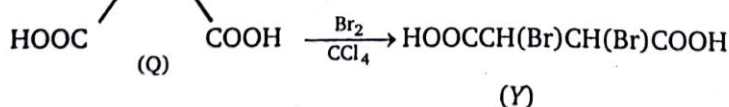
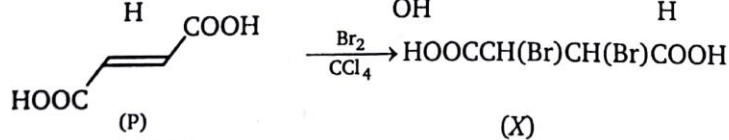
(b) $(H_3C)_2C=CH_2$ → ← $H_2C=C(CH_3)_2$

(c) $H_2C=C(CH_3)_2$ ⇄ $(H_3C)_2C=CH_2$

(d) $H_2C=C(CH_3)-CH_2$ ← $H_2C-\overset{+}{C}(CH_3)_2$

84. Hydroboration of 1-methylcyclopentene using B_2D_6, followed by treatment with alkaline hydrogen peroxide, gives

(a) Me, D, OH, H (b) Me, D, H, OH (c) Me, OH, D, H (d) Me, OH, H, D

85. HOOC–CH=CH–COOH (P) $\xrightarrow[CCl_4]{Br_2}$ HOOCCH(Br)CH(Br)COOH (X)

HOOC–CH=CH–COOH (Q) $\xrightarrow[CCl_4]{Br_2}$ HOOCCH(Br)CH(Br)COOH (Y)

The correct statements with respect to the above pair of reactions are that

(I) the reactions are stereospecific

(II) (X) is erythro and (Y) is threoisomer

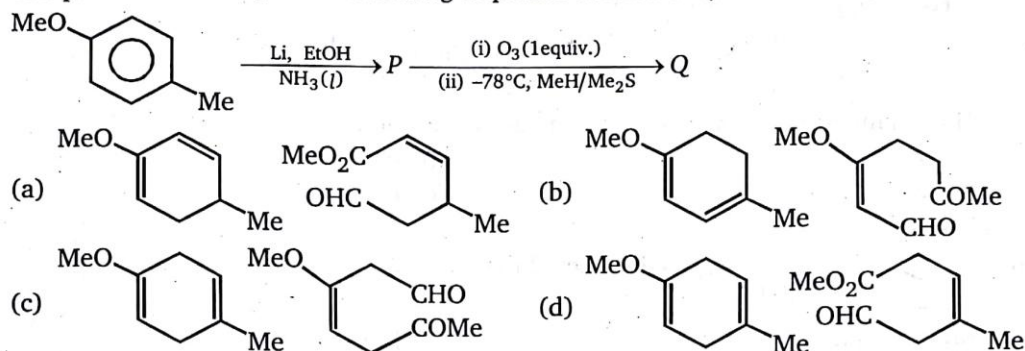
(III) (X) is threo and (Y) is erythro isomer

(IV) each of (P) and (Q) gives a mixture of (X) and (Y)

(a) I and II (b) I and III (c) I and IV (d) II and IV

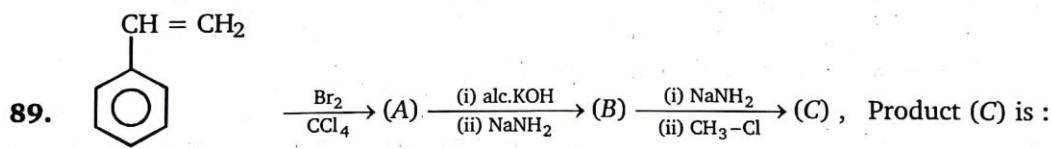
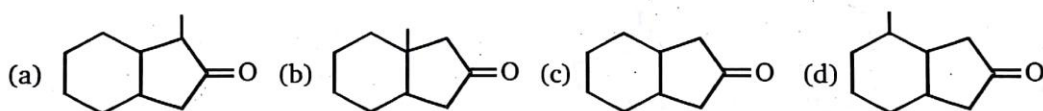
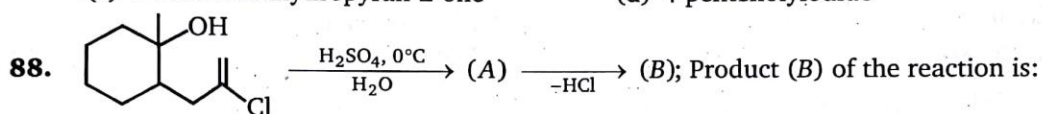
86. The products *P* and *Q* in the following sequence of reactions, are

MeO–C₆H₄–Me $\xrightarrow[NH_3(l)]{Li,\ EtOH} P \xrightarrow[(ii)\ -78°C,\ MeH/Me_2S]{(i)\ O_3(1equiv.)} Q$

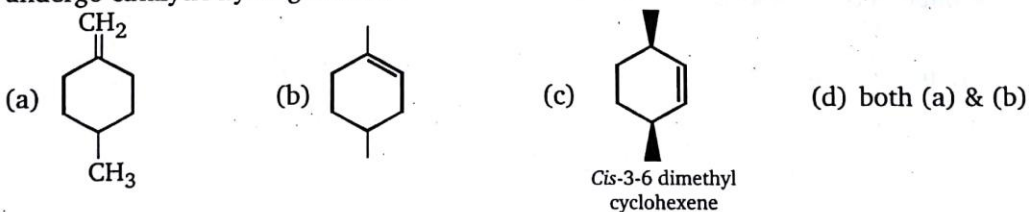
(a)
(b)
(c)
(d)

87. 4-Pentenoic acid when treated with I_2 and $NaHCO_3$ gives :

(a) 4, 5-diiodopentanoic acid
(b) 5-iodomethyl-dihydrofuran-2-one
(c) 5-iodo-tetrahydropyran-2-one
(d) 4-pentenolyiodide

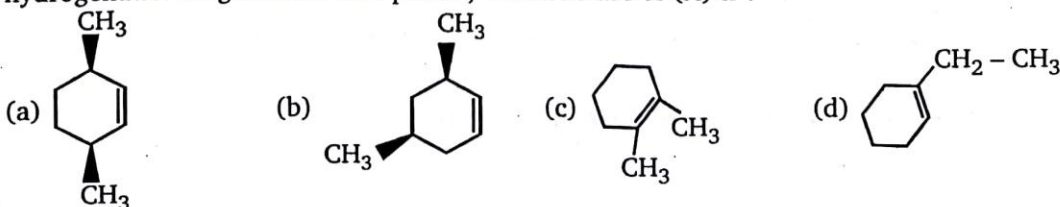
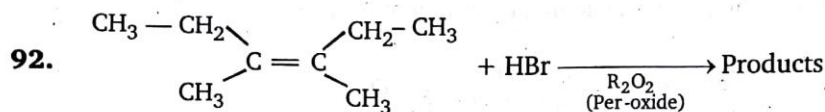
88. $\xrightarrow[H_2O]{H_2SO_4,\ 0°C} (A) \xrightarrow{-HCl} (B)$; Product (*B*) of the reaction is:

89. (Styrene) $\xrightarrow[CCl_4]{Br_2} (A) \xrightarrow[(ii)\ NaNH_2]{(i)\ alc.KOH} (B) \xrightarrow[(ii)\ CH_3-Cl]{(i)\ NaNH_2} (C)$, Product (*C*) is :

(a) $Ph-C\equiv CNa$
(b) $Ph-CH_2-C\equiv CH$
(c) $Ph-C\equiv C-CH_3$
(d) $Ph-CH=C=CH_2$

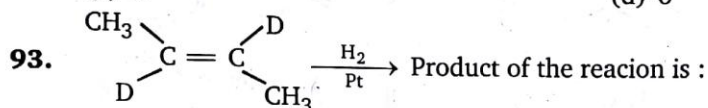
90. Which of the following will give a mixture of *cis* and *trans*-1,4-dimethyl cyclohexane, when undergo catalytic hydrogenation ?

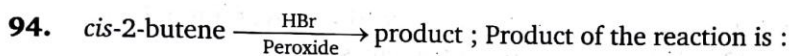
(a)
(b)
(c)
Cis-3-6 dimethyl cyclohexene
(d) both (a) & (b)

91. An optically active compound *A* with molecular formula C_8H_{14} undergoes catalytic hydrogenation to give meso compound, the structure of (*A*) is :

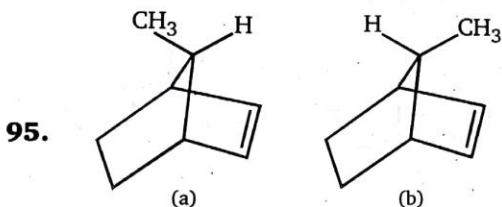
(a)
(b)
(c)
(d)

92. $CH_3-CH_2(CH_3)C=C(CH_2-CH_3)(CH_3)$ + HBr $\xrightarrow[\text{(Per-oxide)}]{R_2O_2}$ Products

How many products will be formed in above reaction ?

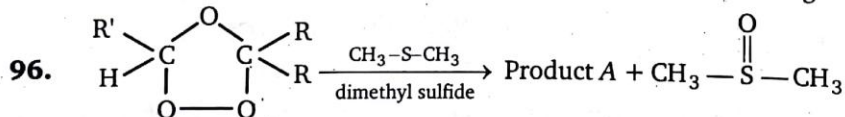
(a) 2
(b) 4
(c) 3
(d) 6

93. $CH_3(D)C=C(D)CH_3$ $\xrightarrow[Pt]{H_2}$ Product of the reacion is :

(a) Racemic
(b) Diastereomers
(c) Meso
(d) Pure enantiomers

94. *cis*-2-butene $\xrightarrow[\text{Peroxide}]{HBr}$ product ; Product of the reaction is :

(a) Racemic
(b) Diastereomer
(c) Meso
(d) *E* and *Z* isomer

95.

Rate of reaction towards reduction using (H_2/Pt) :

(a) $a > b$
(b) $a = b$
(c) $b > a$
(d) Reduction of given molecule is not possible

96. (ozonide: R'(H)C–O–C(R)(R) with O–O bridge) $\xrightarrow[\text{dimethyl sulfide}]{CH_3-S-CH_3}$ Product *A* + $CH_3-\overset{O}{\overset{\|}{S}}-CH_3$

Product *A* of the above reaction is :

(a) $R-\overset{O}{\overset{\|}{C}}-R$
(b) R′ — CHO
(c) $R-CO_2H$
(d) both (a) and (b)

97.

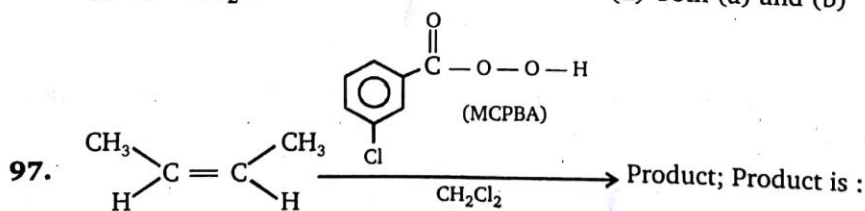
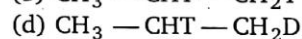
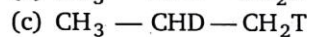
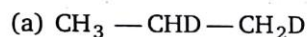
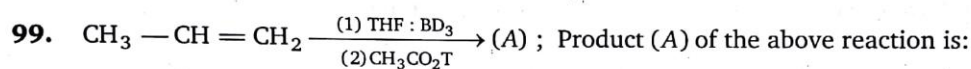
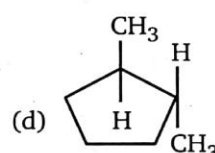
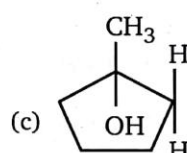
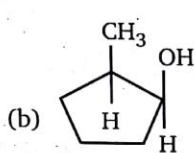
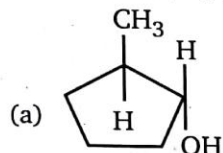
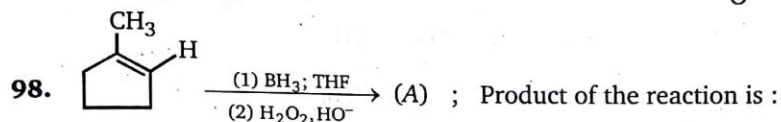
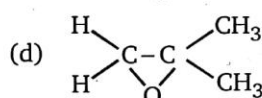
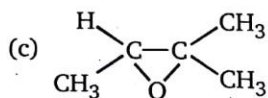
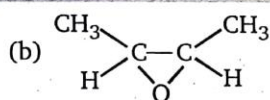
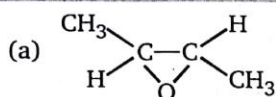
$\longrightarrow$ Product; Product is :

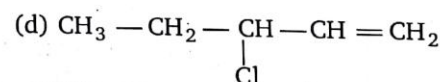
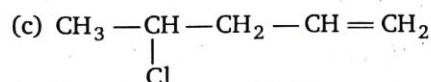
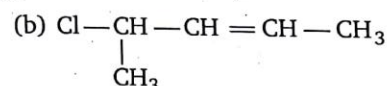
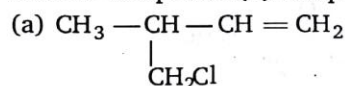
MCPBA $\longrightarrow$ Metachloroperbenzoic acid

(a) CH_3, H–C—C–H, CH_3 (epoxide, O bridging)
(b) CH_3, H–C—C–CH_3, H (epoxide, O bridging)
(c) H, CH_3–C—C–CH_3, CH_3 (epoxide, O bridging)
(d) H, H–C—C–CH_3, CH_3 (epoxide, O bridging)

98. 1-methylcyclopentene (CH_3, H) $\xrightarrow[(2)\ H_2O_2,\ HO^-]{(1)\ BH_3;\ THF}$ (A) ; Product of the reaction is :

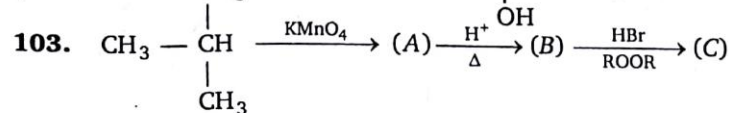
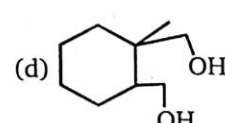
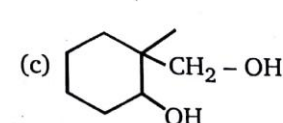
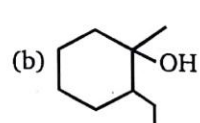
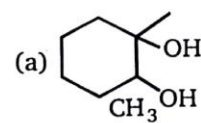
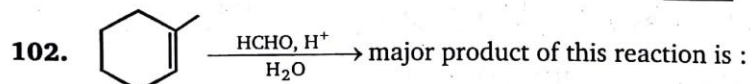
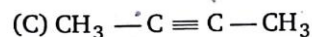
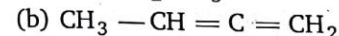
(a) CH_3, H, H, OH (b) CH_3, OH, H, H (c) CH_3, H, OH, H (d) CH_3, H, H, CH_3

99. $CH_3-CH=CH_2 \xrightarrow[(2)\ CH_3CO_2T]{(1)\ THF : BD_3} (A)$; Product (A) of the above reaction is:

(a) $CH_3-CHD-CH_2D$
(b) $CH_3-CHT-CH_2T$
(c) $CH_3-CHD-CH_2T$
(d) $CH_3-CHT-CH_2D$

100. Optically active isomer (A) of (C_5H_9Cl) on treatment with one mole of H_2 gives an optically inactive compound (B) compound (A) will be :

(a) $CH_3-CH(CH_2Cl)-CH=CH_2$
(b) $Cl-CH(CH_3)-CH=CH-CH_3$
(c) $CH_3-CH(Cl)-CH_2-CH=CH_2$
(d) $CH_3-CH_2-CH(Cl)-CH=CH_2$

101. An organic compound C_4H_6 on ozonolysis give HCHO, CO_2, CH_3CHO. Compound will be :

(a) $H_2C=CH-CH=CH_2$
(b) $CH_3-CH=C=CH_2$
(C) $CH_3-C\equiv C-CH_3$
(d) cyclobutene

102. 1-methylcyclohexene $\xrightarrow[H_2O]{HCHO,\ H^+}$ major product of this reaction is :

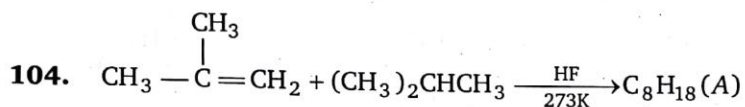
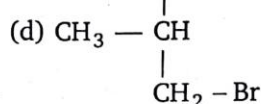
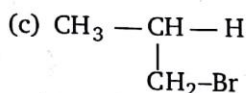
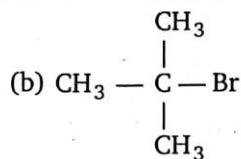
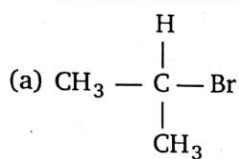
103. $CH_3-CH(CH_3)-CH_3 \xrightarrow{KMnO_4} (A) \xrightarrow[\Delta]{H^+} (B) \xrightarrow[ROOR]{HBr} (C)$

Product (C) in the above reactions is :

(a) $CH_3-\overset{H}{\underset{CH_3}{C}}-Br$

(b) $CH_3-\overset{CH_3}{\underset{CH_3}{C}}-Br$

(c) $CH_3-\underset{CH_2-Br}{CH}-H$

(d) $CH_3-\overset{CH_3}{\underset{CH_2-Br}{CH}}$

104. $CH_3-\overset{CH_3}{C}=CH_2+(CH_3)_2CHCH_3 \xrightarrow[273K]{HF} C_8H_{18}(A)$

Unknown (*A*) in the above reaction is :

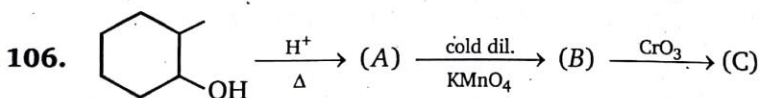
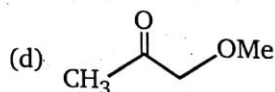
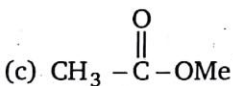
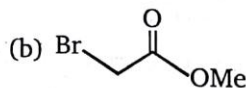
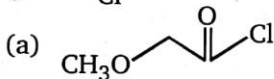
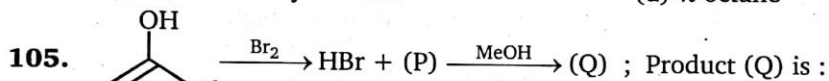
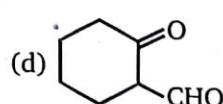
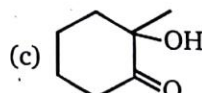
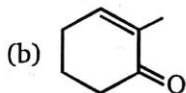
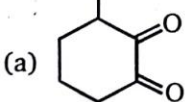
(a) 2, 2, 3-trimethyl pentane
(b) 2, 2, 4-trimethyl pentane
(c) 2, 2-dimethyl hexane
(d) *n*-octane

105. $CH_2=C(OH)CH_2Cl \xrightarrow{Br_2} HBr + (P) \xrightarrow{MeOH} (Q)$; Product (Q) is :

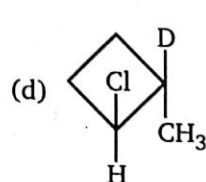
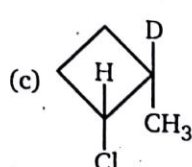
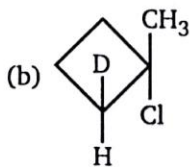
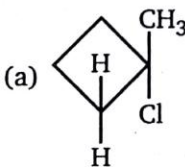
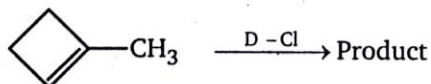
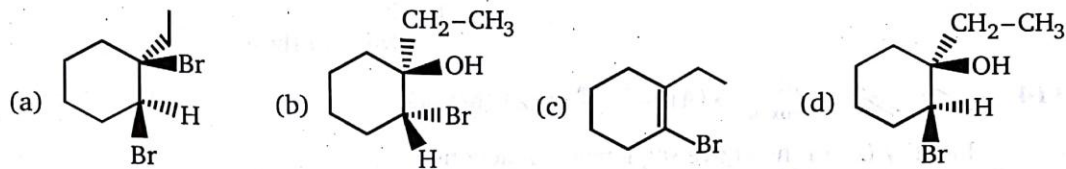
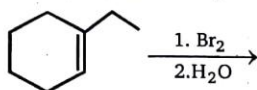
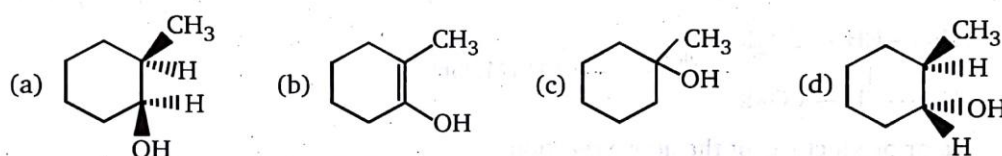
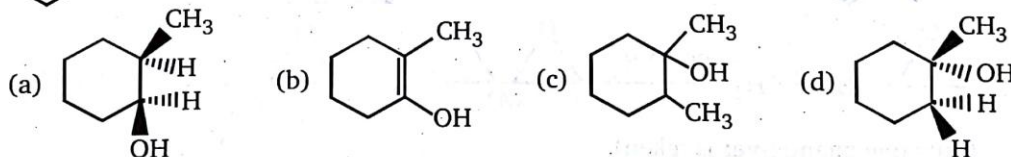
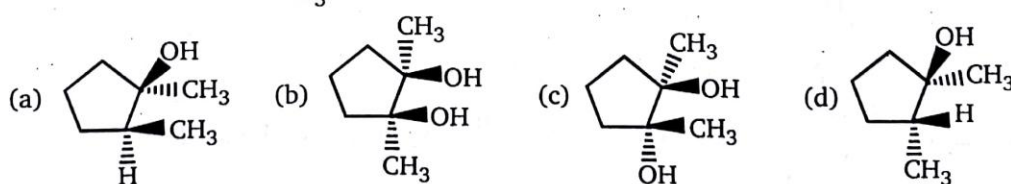
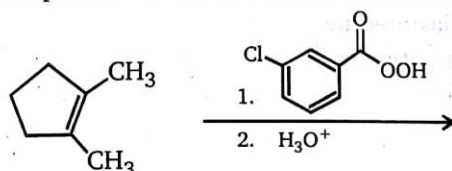
(a) $CH_3O-CH_2-C(=O)-CH_2-Cl$
(b) $Br-CH_2-CH_2-C(=O)-OMe$
(c) $CH_3-\overset{O}{\overset{||}{C}}-OMe$
(d) $CH_3-C(=O)-CH_2-OMe$

106. 2-methylcyclohexanol $\xrightarrow[\Delta]{H^+} (A) \xrightarrow[KMnO_4]{\text{cold dil.}} (B) \xrightarrow{CrO_3} (C)$

Product (*C*) of the reaction is:

(a) 3-methylcyclohexane-1,2-dione (b) 2-methylcyclohex-2-enone (c) 2-hydroxy-2-methylcyclohexanone (d) 2-oxocyclohexanecarbaldehyde (CHO)

107. What is the major product expected from the following reaction ?

1-methylcyclobutene $\xrightarrow{D-Cl}$ Product

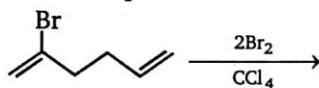
(a) H, H / CH_3, Cl
(b) D, H / CH_3, Cl
(c) H, Cl / D, CH_3
(d) Cl, H / D, CH_3

108. Choose the correct product of this reaction :

111. Choose the correct product of the following reactions :

112. How many stereoisomeric tetrabromides will be formed in the following reaction ?

$$\xrightarrow[CCl_4]{2Br_2}$$

(a) 2 (b) 3 (c) 4 (d) 6

113. How many stereoisomeric pentabromides will be formed in the following reaction ?

Br

$\xrightarrow[CCl_4]{2Br_2}$

(a) 2
(b) 3
(c) 4
(d) None of these

114. $\xrightarrow[\text{peroxide}]{HCl}$ (*A*) $\xrightarrow[\Delta]{EtONa}$ (*Z*) (major)

Identify (*Z*) in the above sequence of reactions :

(a)
(b)
(c)
(d) CH_3, OEt

115. $CH_3-CH-CO_2K$ | $CH_3-CH-CO_2K$ $\xrightarrow{\text{electrolysis}}$ (*A*) (Major)

Major product (*A*) of the above reaction :

(a)
(b)
(c)
(d)

116. $-CH=CH_2$ $\xrightarrow{CF_3CO_3H}$ (*A*) + (*B*)

(only one enantiomer is taken)

Which of the following statement is correct about *A* and *B* ?

(a) *A* and *B* are mixture of diastereomers
(b) *A* and *B* are mixture of enantiomers
(c) *A* and *B* are optically active
(d) *B* is racemic mixture

117. CH_3, CH_3O, O, H, HO, O $\xrightarrow{NaBH_4}$ *A* $\xrightarrow{O_3}$ *B* $\xrightarrow{H_2O}$ (*C*) (one of the product)

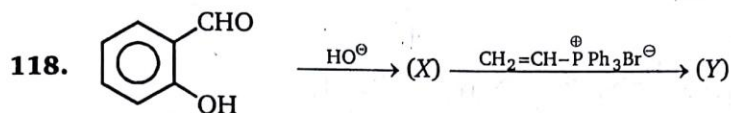
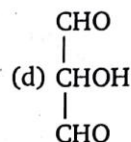
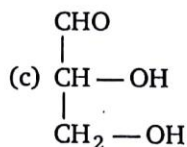
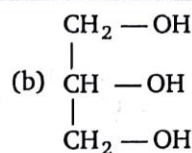
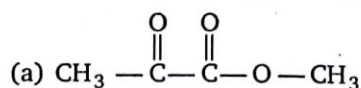
Identify the product (*C*):

(a) $CH_3-\overset{O}{\overset{\|}{C}}-\overset{O}{\overset{\|}{C}}-O-CH_3$

(b) CH_2-OH / $CH-OH$ / CH_2-OH

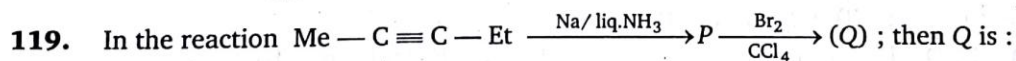
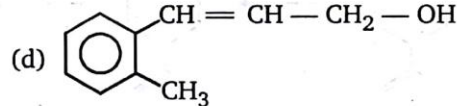
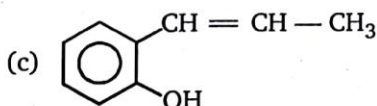
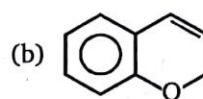
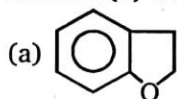
(c) CHO / $CH-OH$ / CH_2-OH

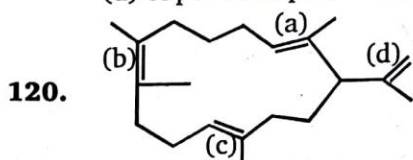
(d) CHO / CHOH / CHO

118. (2-hydroxybenzaldehyde, CHO and OH on benzene ring) $\xrightarrow{HO^{\ominus}}$ (X) $\xrightarrow{CH_2=CH-\overset{\oplus}{P}Ph_3Br^{\ominus}}$ (Y)

Product (Y) of the above reaction is :

(a) (2,3-dihydrobenzofuran) (b) (2H-chromene)

(c) $CH=CH-CH_3$ and OH on benzene ring (d) $CH=CH-CH_2-OH$ and CH_3 on benzene ring

119. In the reaction $Me-C\equiv C-Et \xrightarrow{Na/liq.NH_3} P \xrightarrow[CCl_4]{Br_2} (Q)$; then Q is :

(a) A pure compound which is optically inactive due to internal compensation
(b) A binary mixture which is optically inactive due to external compensation
(c) A binary mixture which is optically active
(d) A pure compound which is optically inactive due to absence of chiral centre

120. (macrocyclic compound with double bonds labelled (a), (b), (c), (d))

Which (π-bond) will reduce first, when above compound undergoes catalytic hydrogenation ?

(a) a (b) b (c) c (d) d

121. Compound A, which is a degradation product of the antibiotic vermiculine has following structure

$CH_3-\overset{O}{\overset{\|}{C}}-CH=CH-CH_2-CH_2-\overset{O}{\overset{\|}{C}}-CH=CH-\overset{O}{\overset{\|}{C}}-OCH_3$

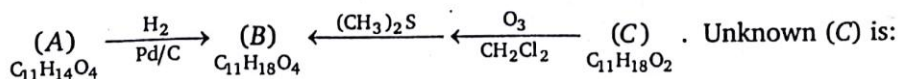
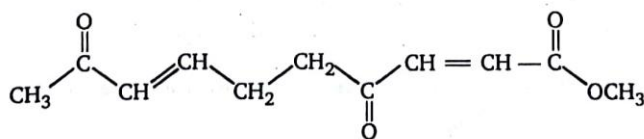
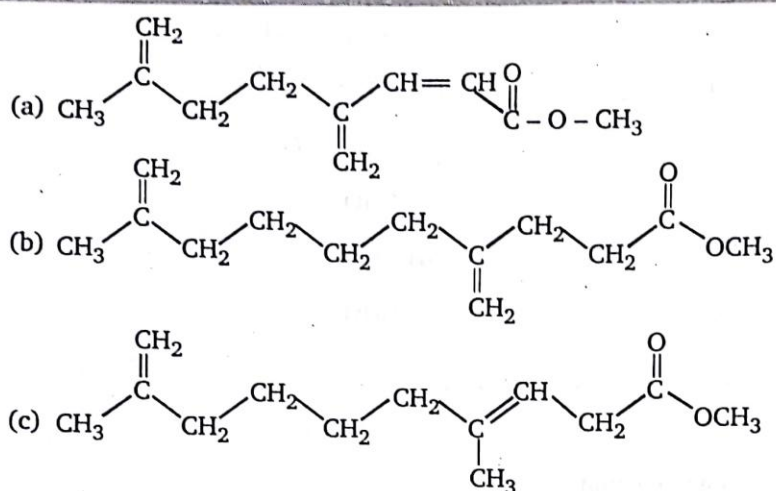
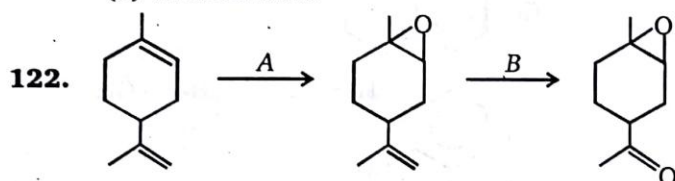
$\underset{C_{11}H_{14}O_4}{(A)} \xrightarrow[Pd/C]{H_2} \underset{C_{11}H_{18}O_4}{(B)} \xleftarrow{(CH_3)_2S} \xleftarrow[CH_2Cl_2]{O_3} \underset{C_{11}H_{18}O_2}{(C)}$. Unknown (C) is:

(a) $CH_3-C(=CH_2)-CH_2-CH_2-C(=CH_2)-CH=CH-C(=O)-O-CH_3$

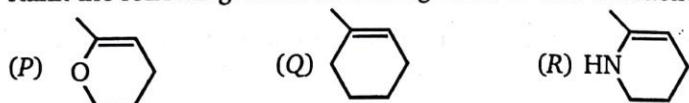
(b) $CH_3-C(=CH_2)-CH_2-CH_2-CH_2-CH_2-C(=CH_2)-CH_2-CH_2-C(=O)-OCH_3$

(c) $CH_3-C(=CH_2)-CH_2-CH_2-CH_2-CH_2-C(CH_3)=CH-CH_2-C(=O)-OCH_3$

(d) None of these

122.

Reagent (*A*) and (*B*) in above reaction are :

(a) $A = RCO_3H, B = H_2O_2$
(b) $A = RCO_3H, B = HIO_4$
(c) $A = RCO_3H, B = O_3$
(d) $A = O_3, B = RCO_3H$

123. Rank the following in the increasing order of rate of reaction with HBr .

(a) $R > P > Q$
(b) $R > Q > P$
(c) $P > R > S$
(d) $P > S > R$

124. Select the reaction(s) that would result in the formation of 2-bromopropane.

(I) $CH_3CH=CH_2 + HBr \xrightarrow{\text{peroxide}}$
(II) $CH_3CH=CH_2 + HBr \xrightarrow{CCl_4}$
(III) $CH_3CH_2CH_3 + Br_2 \xrightarrow{hv}$
(IV) $CH_3CH=CH_2 + Br_2 \xrightarrow{CCl_4}$

(a) I and III
(b) II and III
(c) I, II, and III
(d) I, II and III

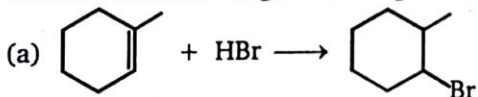
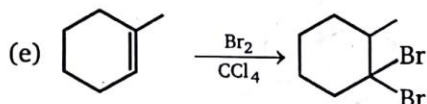
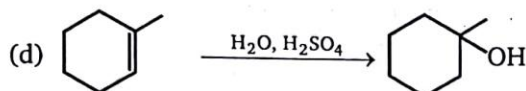
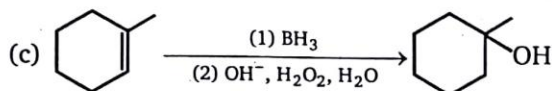
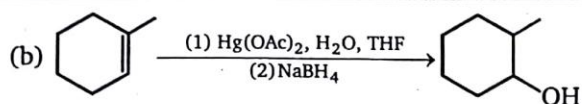
125. Which of the following reactions generates the major product ? Ignore stereoisomerism.

(a) + HBr ⟶ Br

(b) $\xrightarrow[\text{(2) NaBH}_4]{\text{(1) Hg(OAc)}_2\text{, H}_2\text{O, THF}}$ OH

(c) $\xrightarrow[\text{(2) OH}^-\text{, H}_2\text{O}_2\text{, H}_2\text{O}]{\text{(1) BH}_3}$ OH

(d) $\xrightarrow{\text{H}_2\text{O, H}_2\text{SO}_4}$ OH

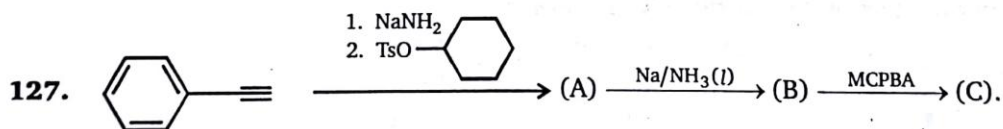
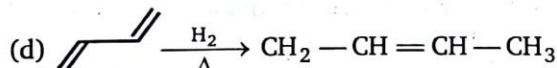
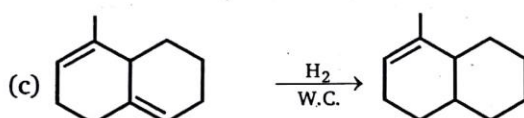
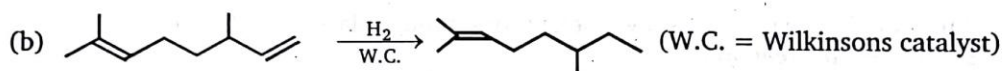
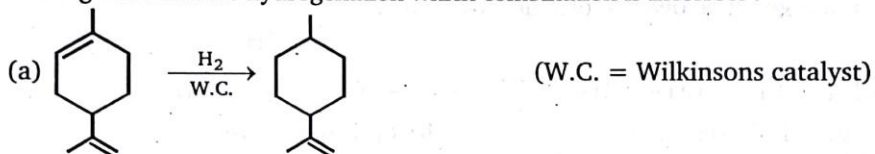
(e) $\xrightarrow[\text{CCl}_4]{\text{Br}_2}$ Br Br

126. In the given selective hydrogenation which combination is incorrect ?

(a) $\xrightarrow[\text{W.C.}]{\text{H}_2}$ (W.C. = Wilkinsons catalyst)

(b) $\xrightarrow[\text{W.C.}]{\text{H}_2}$ (W.C. = Wilkinsons catalyst)

(c) $\xrightarrow[\text{W.C.}]{\text{H}_2}$

(d) $\xrightarrow[\Delta]{\text{H}_2}$ $CH_2-CH=CH-CH_3$

127. $\xrightarrow{\text{1. NaNH}_2 \quad \text{2. TsO}-}$ (A) $\xrightarrow{\text{Na/NH}_3(l)}$ (B) $\xrightarrow{\text{MCPBA}}$ (C).

Compound (*C*) in above sequence of reaction is :

(a) H H O

(b) H O H

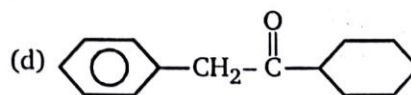
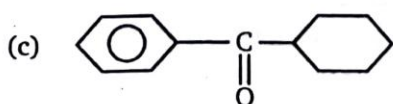
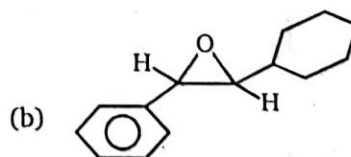
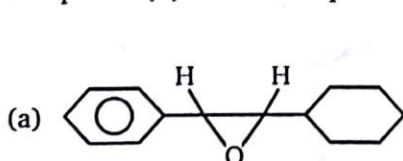
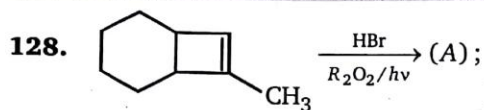
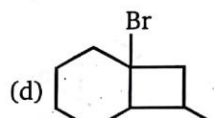
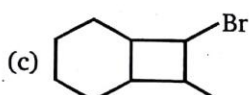
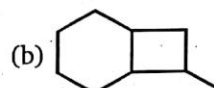
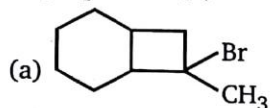
(c) C=O

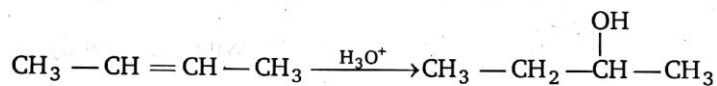
(d) $CH_2-\overset{O}{\overset{\|}{C}}-$

128. (bicyclo[4.2.0]oct-ene with CH_3) $\xrightarrow[R_2O_2/h\nu]{HBr}$ (A);

Major product (A) is :

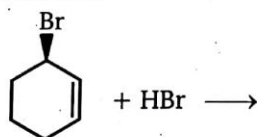
(a) Br, CH_3 (b)

(c) Br (d) Br

129. In the reaction given below, the product would be :

$$CH_3-CH=CH-CH_3 \xrightarrow{H_3O^+} CH_3-CH_2-\underset{|}{\overset{OH}{C}}H-CH_3$$

(a) a mixture of diastereomers (b) optically active

(c) optically pure enantiomer (d) a racemic mixture

130. Surprisingly, the reaction shown below goes through classical carbocation. What is the major product of this reaction ?

Br (3-bromocyclohexene) + HBr ⟶

(a) *trans*-1, 3-dibromocyclohexane (b) *cis*-1, 3-dibromocyclohexane

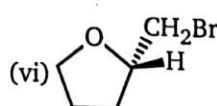
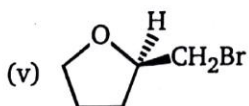
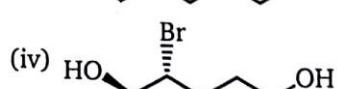
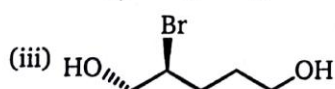
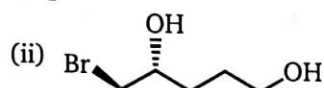
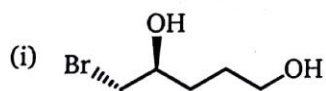
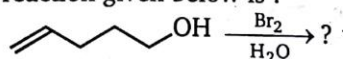
(c) *trans*-1, 2-dibromocyclohexane (d) *cis*-1, 2-dibromocyclohexane

131. The major product of the reaction given below is :

OH $\xrightarrow[H_2O]{Br_2}$?

(i) OH, Br, OH (ii) OH, Br, OH

(iii) Br, HO, OH (iv) Br, HO, OH

(v) O, H, CH_2Br (vi) O, CH_2Br, H

(a) (i) and (ii) (b) (iii) and (iv)

(c) (v) and (vi) (d) none of these

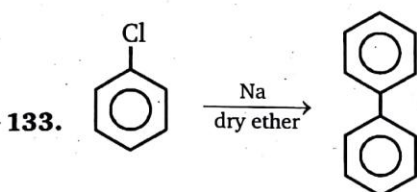
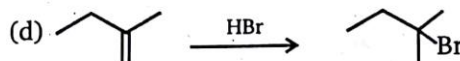
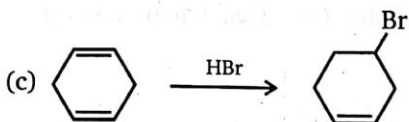
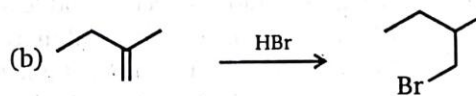
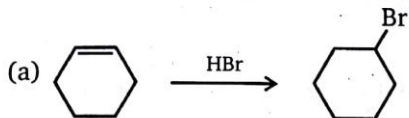
132. Which reaction will occur at the fastest rate ?

(a)

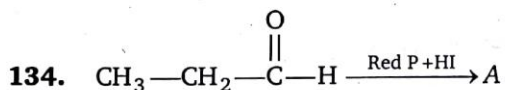
(b)

(c)

(d)

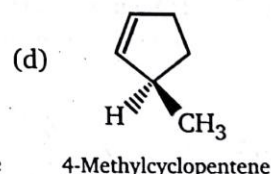
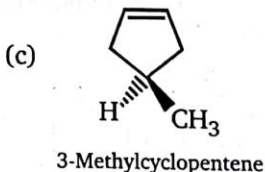
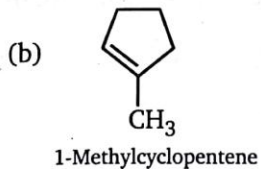
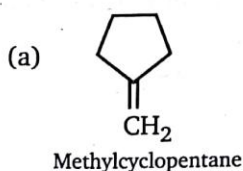
133.

Above reaction is known as :

(a) Wurtz reaction
(b) Wurtz fittig reaction
(c) Fittig reaction
(d) Kolbe electrolysis

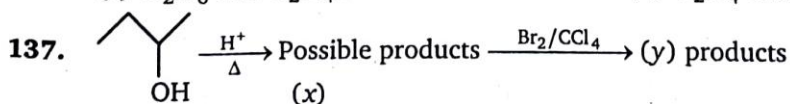
134. $CH_3—CH_2—\overset{O}{\overset{||}{C}}—H \xrightarrow{\text{Red P + HI}} A$

Product A is :

(a) propane (b) propanol (c) prapanoic acid (d) propene

135. Which of the following compound give diastereomers when treated with Br_2 in CCl_4?

Methylcyclopentane 1-Methylcyclopentene 3-Methylcyclopentene 4-Methylcyclopentene

136. A mixture of C_2H_6, C_2H_4 and C_2H_2 is bubbled through alkaline solution of copper (I) chloride, contained in Woulf's bottle. The gas coming out is :

(a) original mixture
(b) C_2H_6
(c) C_2H_6 and C_2H_4 mixture
(d) C_2H_4 and C_2H_2

137.

The number of possible products for x and y is :

(a) 2, 4
(b) 3, 5
(c) 3, 6
(d) 3, 4

138. Select the incorrect statement :

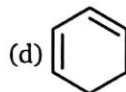
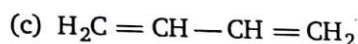
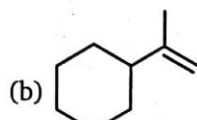
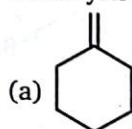
(a) Bromine is more selective and less reactive
(b) Chlorine is less selective and more reactive
(c) Benzyl free radical is more stable than 2° free radical
(d) Vinyl free radical more stable than allyl free radical

139. Which of the following compound does not evolve CO_2 gas, when undergo oxidative ozonolysis ?

(a)

(b)

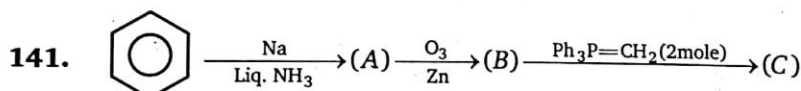
(c) $H_2C=CH-CH=CH_2$

(d)

140. *cis*-3-hexene $\xrightarrow{(a)}$ meso 3,4-hexanediol

trans-3-hexene $\xrightarrow{(b)}$ meso 3,4-hexanediol.

Choose pair of reagent (a, b) for above conversions.

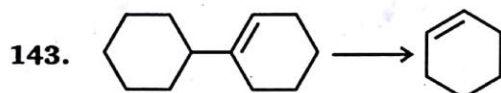
(a) Cold $KMnO_4, OsO_4$
(b) Cold $KMnO_4, RCO_3H/H_3O^{\oplus}$
(c) $RCO_3H/H_3O^{\oplus}$, cold $KMnO_4$
(d) None of these

141. $\xrightarrow[\text{Liq. } NH_3]{Na} (A) \xrightarrow[Zn]{O_3} (B) \xrightarrow{Ph_3P{=}CH_2(2\text{mole})} (C)$

Product (C) of the above reaction is :

(a) 1,3-hexadiene
(b) 1,4-pentadiene
(c) 1,3-butadiene
(d) 1,3-heptadiene

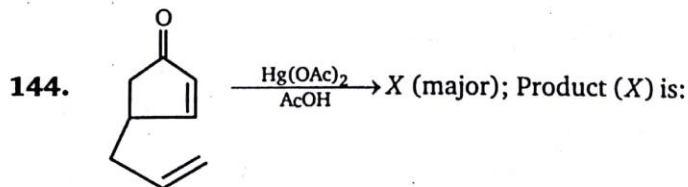
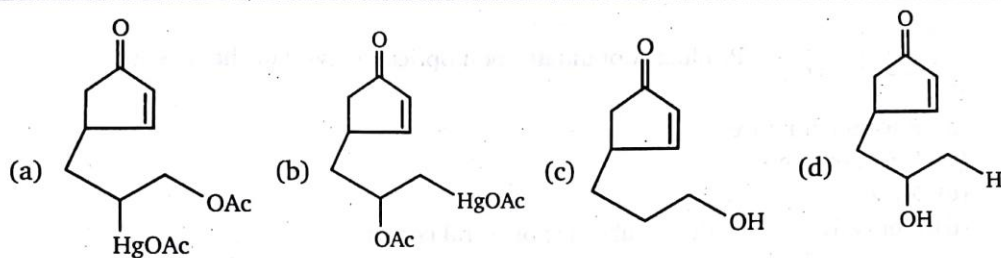
142. How many carbon-hydrogen bond orbitals are available for overlap with the vacant p-orbital in ethyl carbocation ?

(a) 0 (b) 3 (c) 5 (d) 6

143. $\longrightarrow$

To achieve above conversion, the reagents used will be :

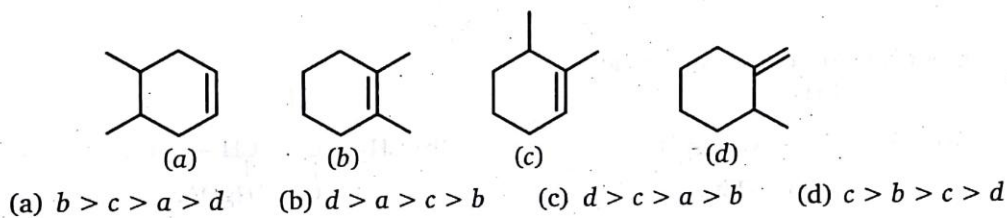
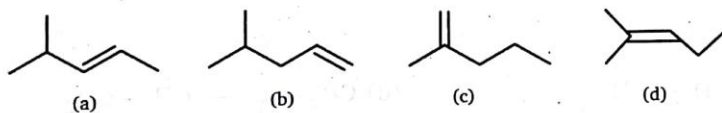
(a) O_3/H_2O_2, HO^-/Δ
(b) HBr, alc. KOH, O_3, $LiAlH_4$, H^+/Δ
(c) HBr, t-BuOK, O_3, $KMnO_4$, Δ
(d) HCl, $KMnO_4$(cold), H^+/Δ

144.

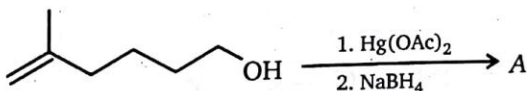
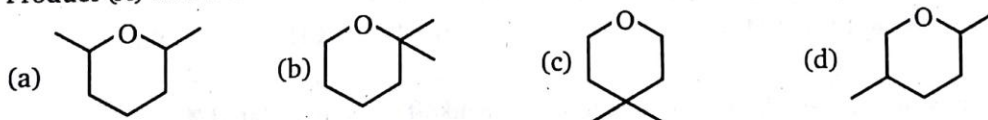
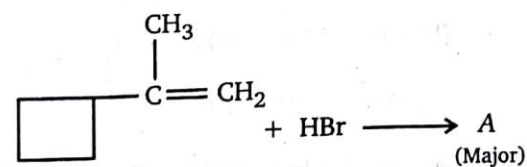
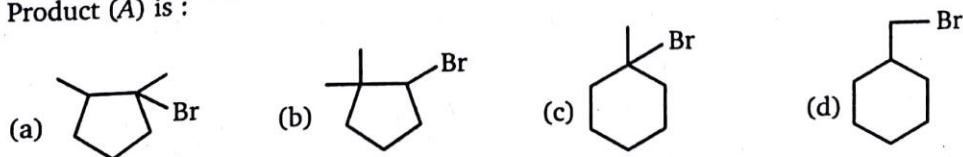
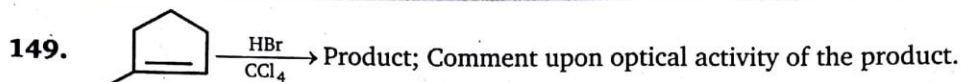
$\xrightarrow[AcOH]{Hg(OAc)_2} X$ (major); Product (X) is:

145. Decreasing order of heat evolved upon catalytic hydrogenation of given reactants with a H_2 (Pd/C) is :

(a) $b > c > a > d$ (b) $d > a > c > b$ (c) $d > c > a > b$ (d) $c > b > c > d$

146.

(a) (b) (c) (d)

The correct order of heat of hydrogenation of given molecules is :

(a) $d > c > a > b$ (b) $d > c > b > a$
(c) $b > a > c > d$ (d) $d > a > c > b$

147. OH $\xrightarrow[\text{2. NaBH}_4]{\text{1. Hg(OAc)}_2}$ A

Product (A) of the above reaction is :

148. CH_3 | C$=$$CH_2$ + HBr ⟶ A (Major)

Product (A) is :

149. (1-methylcyclopentene) $\xrightarrow[CCl_4]{HBr}$ Product; Comment upon optical activity of the product.

(a) Racemic mixture
(b) Diastereomers
(c) Meso
(d) Optically inactive due to absence of chiral center

150. $CH_3-\underset{}{\overset{CH_3}{\overset{|}{C}}}=CH-CH_3 \xrightarrow{Hg(OAc)_2/EtOH} \underset{(90\%)}{(A)}$

Product (*A*) of the above reaction is :

(a) $CH_3-\overset{CH_3}{\overset{|}{\underset{HgOAc}{\underset{|}{C}}}}-\underset{OEt}{\underset{|}{CH}}-CH_3$

(b) $CH_3-\overset{CH_3}{\overset{|}{\underset{OEt}{\underset{|}{C}}}}-\underset{HgOAc}{\underset{|}{CH}}-CH_3$

(c) $CH_3-\overset{CH_3}{\overset{|}{\underset{OH}{\underset{|}{C}}}}-\underset{HgOAc}{\underset{|}{CH}}-CH_3$

(d) $CH_3-\overset{CH_3}{\overset{|}{\underset{HgOAc}{\underset{|}{C}}}}-\underset{OH}{\underset{|}{CH}}-CH_3$

151. $Me_2CH-\underset{OH}{\underset{|}{CH}}-Me \xrightarrow[350°C]{Al_2O_3} (A) \xrightarrow[(ii)\ AgOH]{(i)\ HI} (B)$

Product (*B*) of above reaction :

(a) $Me_2C(OH)CH_2Me$

(b) $Me_2CH-\underset{OH}{\underset{|}{CH}}-Me$

(c) $Me-\underset{OH}{\underset{|}{CH}}-CMe_3$

(d) $HO-CH_2-(CH_2)Me$

152. In which of the following reaction, Markownikoff's rule is violated ?

(a) $CH_3-O-CH=CH_2 \xrightarrow[CCl_4]{HBr}$

(b) $CH_3-NH-CH=CH_2 \xrightarrow[CCl_4]{HBr}$

(c) $CH_3-S-CH=CH_2 \xrightarrow[CCl_4]{HBr}$

(d) $O_2N-CH=CH_2 \xrightarrow[CCl_4]{HBr}$

153. Decreasing order of rate of reaction of molecules towards electrophilic addition reaction is :

(a) $a > b > c > d$ (b) $b > c > a > d$
(c) $d > b > c > a$ (d) $b > d > c > a$

154. $2CH_3-\underset{\underset{Ph}{|}}{C}=CH_2 \xrightarrow{\text{H-}A\text{(acid)}} \underset{\text{(major)}}{(A)}$

Product (A) is :

(a)

(b)

(c)

(d)

155.

$\xrightarrow[\Delta]{H^+} (A) \xrightarrow[H^{\oplus}]{ROH} \underset{\text{(major)}}{(B)}$

Product (B) of the above reaction is :

(a)

(b)

(c)

(d)

156. Which of the following compounds gives the same carbocation on ionization ?

Br Br Br

Br

1 2 3 4

(a) 1 and 3 (b) 2 and 4
(c) 1 and 2 (d) 1 and 4

157. For the following reactions the major products are shown :

$H_2C=CH-CH=CH_2 \xrightarrow[0°C]{HBr} H_2C=CH-\underset{\underset{Br}{|}}{CH}-CH_3 \xrightarrow{+\ 25°C} \underset{\underset{Br}{|}}{CH_2}CH=CHCH_3$

These provide an example of __1__ control at low temperature and __2__ control at higher temperature.

	1	2		1	2
(a)	kinetic	thermodynamic	(b)	thermodynamic	kinetic
(c)	kinetic	kinetic	(d)	thermodynamic	thermodynamic

158. What is the product of 1, 4-addition in the reaction shown below ?

159. CH_3, H / H, OH (cyclohexane ring)

Dehydration of the above compound will give :

(a) meso product
(b) racemic mixture
(c) diastereomer
(d) optically pure enantiomer

160. CH_2-CH_3 / H — C — Cl / $CH=CH_2$ $\xrightarrow[CCl_4]{HBr}$

What is stereochemistry of product ?

(a) Racemic mixture
(b) Optically inactive
(c) Diastereomers
(d) Meso product

161. ≡—/\/\/OH $\xrightarrow{H_2}$ A $\xrightarrow{H^{\oplus}}$ (ring with O, CH_3)

End product formed in the above reaction is :

(a) Optically active
(b) Racemic
(c) Meso
(d) Diastereomer

162. How many moles of BH_3 are needed to react completely with 2 mole of 1-pentene in hydroboration-oxidation reaction ?

(a) 2 mole
(b) 3 mole
(c) 2/3 mole
(d) 3/2 mole

163. (benzene ring with OCH_3) $\xrightarrow[\text{Liq. } NH_3]{Li}$ A $\xrightarrow{H_3O^+}$ B

Product (B) in the above reaction is :

164. $H_2\overset{14}{C}=CH-CH_3 \xrightarrow[\text{or high temp}]{\text{low conc. of } Br_2} (?)$

Product of the above reaction is :

(a) $H_2\overset{14}{C}=CH-CH_2-Br$

(b) $H_2C=CH-\overset{14}{C}H_2-Br$

(c) $\overset{14}{C}H_2(Br)-CH(Br)-CH_3$

(d) both (a) and (b)

165. In which of the following reactions 1,3-butadiene will be obtained as a major product ?

(a) $Br-CH_2-CH_2-CH_2-CH_2-Br \xrightarrow[(CH_3)_3COH]{(CH_3)_3COK\,(2\,mole)}$

(b) $HO-CH_2-CH_2-CH_2-CH_2-OH \xrightarrow{\text{Conc. } H_2SO_4}$

(c) $H_2C=CH-C\equiv CH \xrightarrow[Ni_2B]{H_2(1\,mole)}$

(d) All of these

166. $H_2C=C(CH_3)_2 \xrightarrow[20°C]{Cl_2} \xrightarrow[2.\ Ca(OH)_2]{1.\ H_2O} \xrightarrow[\Delta]{H^+} A$; Identify A.

(a) $CH_3-C(CH_3)(-O-)CH_2$ (epoxide)

(b) $CH_3-CH(CH_3)-CHO$

(c) $CH_3-\overset{O}{\overset{\|}{C}}-CH_2-CH_3$

(d) $CH_3-C(CH_3)=CH_2$

167. [Structure: cyclohexene ring bearing a $-CH_2-CH_2-CH(OH)-C(CH_3)_3$ chain] $\xrightarrow[\Delta]{H_2SO_4} A$;

Product (A) is :

(a) [Structure]

(b) [Structure]

(c) [Structure]

(d) [Structure]

168. (Ring structure: CH_3 at carbon *d* on the double bond, ring positions *c*, *b*, *a*; carbon *a* bears H and CH_3) $\xrightarrow{\text{NBS}}$ *A* (major)

Bromination take place at :

(a) *a* (b) *b* (c) *c* (d) *d*

169. Which is incorrect statement about heats of combustion ?

(a) Ethylcyclohexane > Ethylcyclopentane > Ethylcyclobutane (drawn as skeletal structures)

(b) Spiro/bicyclic structures drawn as skeletal structures, in the order shown: $\triangleright\!-\!\triangleleft$ > $\triangleright\!\triangleleft$ > bicyclic structure

(c) Iso-butene > *trans*-2-butene > 1-butene (d) n-Hexane < n-Heptane < n-Octane

170. Predict the major product of the reaction.

$$CH_3-\underset{\underset{CH_3}{|}}{C}=\overset{\overset{CH_3}{|}}{C}-CH_2-CH=CH_2 \xrightarrow[H^+]{m\text{-}ClC_6H_4COOH \text{ (Cl, O, COOH as drawn)}} \text{(Product)}$$

(a) $CH_3-\overset{\overset{CH_3}{|}}{C}=\overset{\overset{CH_3}{|}}{C}-CH_2-\underbrace{CH-CH_2}_{O}$ (epoxide)

(b) $CH_3-\overset{\overset{CH_3}{|}}{C}-\overset{\overset{CH_3}{|}}{C}-CH_2-CH=CH_2$ (epoxide O bridging the two substituted carbons)

(c) $CH_3-\overset{\overset{CH_3}{|}}{C}=\overset{\overset{CH_3}{|}}{C}-CH_2-\underset{\underset{OH}{|}}{CH}-\underset{\underset{OH}{|}}{CH_2}$

(d) $CH_3-\underset{\underset{OH}{|}}{\overset{\overset{CH_3}{|}}{C}}-\underset{\underset{OH}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_2-CH=CH_2$

171. (1,2-Dihydronaphthalene) $\xrightarrow{\text{cold dil. } KMnO_4}$ Product of the reaction is:

(a) Meso compound (b) Enantiomeric pair

(c) Diastereomers (d) Optically pure enantiomer

172.

Product (*A*) of above reaction is:

(a) $CH_3O-\underset{\large CO_2H}{\underset{|}{CH}}-CH_2-CH_2-CHO$

(b) $CH_3O-CH_2-\overset{\large CO_2H}{\overset{|}{CH}}-CH_2-CO_2H$

(c) $CH_3O-\underset{\large CO_2H}{\underset{|}{CH}}-CH_2-CH_2-CO_2H$

(d) $CH_3O-\underset{\large CO_2H}{\underset{|}{CH}}-CH_2-CH_2-CH_2-CHO$

173. O $\xrightarrow[10\%\,Pd/C]{H_2\ (2\text{-}3atm)(1\ mole)}$ Products ; Comment up on optical activity of products.

(a) Diastereomers (b) Racemic mixture (c) Meso (d) Optically pure enantiomer

174. O + HBr (1 mole) ⟶ Product

Addition of a mineral acid to an olefin bond leads to major product, Identify it:

(a)

(b) O Br

(c) O Br

(d) Br O

175. $\xrightarrow[PtO_2]{H_2\,(one\ mole)}$ Product

In polyenes that contain differently substituted (C=C) double bonds, it is possible to hydrogenate chemeselectively one (C=C) double bond. Product is :

(a)

(b)

(c)

(d)

176.

(MCPBA ⟶ meta-chloro perbenzoic acid)

Stereochemistry of the product of above reaction is :

(a) Meso (b) Racemic

(c) Diastereomers

(d) Optically inactive due to absence of chiral center.

177. O; Conc. H_2SO_4 ⇌ P

Identify product (P).

(a)

(b)

(c)

(d)

178. H_2SO_4 ⇌ B

A

A isomerise to B on addition of traces of acid H_2SO_4. Compound (B) is :

179. R OH; $SOCl_2$, pyridine, Δ ⟶ A

Product (A) of the reaction is :

(d) None of these

180. HO— ... $\xrightarrow[\Delta]{H^+ \text{(excess)}}$ (*A*). Product (*A*) is :

(a) (b) (c) (d)

181. Which of the following reactions do not represent the major product of given Birch reductions ?

(vi) $\xrightarrow[\text{liq. } NH_3]{Na}$

(vii) 2-butyne $\xrightarrow[\text{liq. } NH_3]{Na}$ *cis*-2-butene

(a) (i), (iii), (vi)
(b) (iv), (vi), (vii)
(c) (iv), (v), (vi)
(d) (i), (ii), (v), (vii)

182.

Product (*A*) is:

(a) OH ... OR (b) OH ... OR (c) OH, OH ... OR (d) OR, OH

Hint : Think carefully about the relative stabilization of developing positive charge, when the double bond reacts with an electrophile.

183. Cyclohexene $\xrightarrow{HOCl}$ (A) $\xrightarrow[H_2O,\ 25°C]{NaOH,}$ (B) 70%

Correct statement about above reaction is:

(a) A = *cis*-2-chlorocyclohexanol, B = cyclohexeneoxide

(b) A = *trans*-2-chloro cyclohexanol, B = anti-diol

(c) A = *trans*-2-chlorocyclohexanol, B = cyclohexeneoxide

(d) A = *cis*-2-chlorocyclohexanol, B = anti-diol

184. $\xrightarrow{H^{\oplus}}$ Predict the major product:

(a) HO (b) HO (c) HO (d)

185. $\xrightarrow{H_2SO_4}$ (A) (*Major*) ; Product (A) is :

(a) (b) OH (c) OH (d) OH

186. Br, H $\quad {}^{82}Br-{}^{82}Br \xrightarrow{CCl_4}$ Major product of the reaction is :

(a) Br, H, Br^{82}, Br^{82} (b) Br^{82}, Br, H, Br^{82} (c) Br^{82}, Br^{82}, H, Br (d) Br^{82}, Br^{82}, H

187. H CH$_3$ $\xrightarrow[CCl_4]{Br_2}$ stereochemistry of the product is:

(a) Diastereomers (b) Racemic mixture
(c) Meso (d) Pure Enantiomers

188. H CH$_3$ $\xrightarrow[CCl_4]{Br_2}$ Product/s obtained is/are :

(a) Diastereomers (b) Racemic
(c) Meso (d) Optically pure enantiomers

189. O $\xrightarrow{Ph_3P=CH_2}$ $\xrightarrow{Ph_3P=CH_2}$ (x) ; Product (x) is :

(a)

(b)

(c) CH–CH$_3$

(d)

190. $CH_3-CH_2-CH_2-CH_2-\underset{CH_3}{\overset{CH_3}{|}}{C}-CH_2-OH \xrightarrow[\Delta]{H^+} \underset{\text{(major)}}{(A)}$; Product (A) is :

(a) $CH_3-CH_2-CH_2-CH_2-\underset{CH_3}{C}=CH-CH_3$

(b) $CH_3-CH_2-CH_2-CH_2-CH=C\begin{smallmatrix}CH_3\\CH_3\end{smallmatrix}$

(c) $CH_3-CH_2-CH_2-CH_2-\underset{CH_3}{C}=CH_2$

(d) $CH_3-CH_2-\underset{CH_3}{CH}-CH_2-\overset{CH_3}{C}=CH_2$

191. $CH_3-CH=CH-CH_3 \xrightarrow[R_2O_2,\Delta]{HBr}$
(Anti–Markownikoff's addition)

Comment on optical activity of the products:

(a) Racemic (b) Diastereomer
(c) Meso (d) Optically pure enantiomer

192. $\xrightarrow{CH_3-\overset{O}{\overset{\|}{C}}-O-O-H}$ (A) ; Product (A) is :
(major)

(a) (b) (c) OH OH (d) OH OH

193. A (alkene) $\xrightarrow[H_2O]{RCO_3H}$ Racemic mixture; $\xrightarrow{\text{Cold dil. }KMnO_4}$ Meso-compound

Alkene (A) will be :

(a) *cis*-2-pentene (b) *cis*-2-hexene
(c) *cis*-4-octene (d) *trans*-2-hexene

194.

Product (A) is

(a) *trans*-2-butane (b) *cis*-2-butene (c) 1-butene (d) Iso-butene

195. In which of the following reactions, two products will be formed other than phosphonium ylide ($POPh_3$)

(a) (cyclohexanone) $+ Ph_3P=CH_2 \longrightarrow$

(b) $CH_3CHO + Ph_3P=\underset{CH_3}{\underset{|}{C}}-CH_3 \longrightarrow$

(c) $Ph-\overset{O}{\overset{\|}{C}}-H + Ph_3P=CH-Ph \longrightarrow$

(d) $H-\overset{O}{\overset{\|}{C}}-H + Ph_3P=CH-CH_3 \longrightarrow$

196. To carry out the given conversions, select the correct option:

$$R_1R_2C(O{-}O)(O)CHR_2 \xrightarrow{a} R_1-\overset{O}{\overset{\|}{C}}-R_2 + R_2CO_2H$$

$$\xrightarrow{b} R_1-\overset{O}{\overset{\|}{C}}-R_2 + R_2-CHO$$

$$\xrightarrow{c} R_1-\overset{OH}{\overset{|}{CH}}-R_2 + R_2-CH_2-OH$$

(a) $a = Ag_2O$, $b = Zn/CH_3CO_2H$, $c = LiAlH_4$
(b) $a = H_2O_2$, $b = CH_3-S-CH_3$, $c = NaBH_4$
(c) Both (a) and (b)
(d) None of these

197. The product (*A*) of given alkoxymercuration de-mercuration is :

$$\text{1-methylcyclohexene} \xrightarrow[(2)\,NaBH_4,\,HO^-]{(1)\,Hg(O_2CCF_3)_2,\ CH_3OH} \underset{\text{(major)}}{(A)}$$

(a) 2-methylcyclohexyl methyl ether (OCH_3)
(b) 1-methoxy-1-methylcyclohexane (OCH_3)
(c) 1-methylcyclohexanol (OH)
(d) 2-methylcyclohexanol (OH)

198. $CH_3-\overset{ONa}{\overset{|}{C}}=CH_2 \xrightarrow{HC\equiv CH} \xrightarrow{H^+} \xrightarrow[Pd\text{-}BaSO_4]{H_2} \xrightarrow[\Delta]{Al_2O_3}$

End product of the reaction is :

(a) $H_2C=CH-\underset{CH_3}{\underset{|}{C}}=CH_2$
(b) $CH_3-CH=CH-CH=CH_2$
(c) $H_2C=CH-CH=CH_2$
(d) $H_2C=CH-CH_2-CH=CH_2$

199. Major product of the given reaction is :

$H_2C=CH-CH_2-I \xrightarrow[CCl_4]{HI\,(excess)}$

(a) $CH_3-\underset{I}{\underset{|}{CH}}-\underset{I}{\underset{|}{CH_2}}$
(b) $CH_3-\underset{I}{\underset{|}{CH}}-CH_3$
(c) $CH_3-CH_2-CH_2-I$
(d) $I-CH_2-CdH_2-CH_2-I$

200. The rate constant for a reaction can be increased by $\underline{a}$ the stability of the reactant or by $\underline{b}$ the stability of the transition state. Select the correct choice for a and b.

(a) decreasing, decreasing
(b) increasing, decreasing
(c) decreasing, increasing
(d) increasing, increasing

201. Major product of the given reaction is :

$H_2C=CH_2$ + $(CH_3)_2C{=}CH_2$ $\xrightarrow[\Delta]{H^+}$ Product

(a)

(b)

(c)

(d) $H_2C=C(CH_3)-CH_2-CH_2-CH_3$

202. Cyclohexanone + $Ph_3P{=}CH_2 \longrightarrow (A)$ Major

Major product (A) is :

(a) (b) (c) (d)

OH

203. In the given reaction, only one alkene undergo preferential oxidation by electrophilic ozone. Identify product (P) of the given reaction:

OMe

$\xrightarrow[Me_2S,\ -78°C\ \text{then}\ NaBH_4]{O_3}$ (P) (>52%)

(a) CO_2Me CHO

(b) CO_2Me OH

(c) $CH_3-\overset{O}{\overset{\|}{C}}-CH_2-CH=\underset{OMe}{\underset{|}{C}}-CH_2-CHO$

(d) $CH_3-\overset{OH}{\overset{|}{CH}}-CH_2-CH=\underset{OMe}{\underset{|}{C}}-CH_2-CH_2-OH$

204. $\xrightarrow[\text{(major)}]{HCl}$ (P) ; Product (P) is:

OH, $CH_2—CH_2—CH=CH_2$

(a) (b) Cl (c) Cl (d) Cl

205. CO_2H $\xrightarrow[NaHCO_3]{I_2}$ (A) ; Major product of the reaction is :

(a) O, O, I (b) I, O, O

(c) O, O (d) I, O, O

206. OH, OMe $\xrightarrow[Pd-BaSO_4]{H_2}$ (A) $\xrightarrow{H_3O^{\oplus}}$ (B)

Product (B) is :

(a) $Ph-\underset{|}{\overset{OH}{CH}}-CH=CH-CH_2-\overset{O}{\overset{||}{C}}-H$

(b) $Ph-CH=CH-CHO$

(c) $Ph-(CH=CH)_2-CHO$

(d) $Ph-(CH=CH)_3-CHO$

207. Isobutene, in the presence of H_2SO_4, forms a mixture of two isomeric alkene (C_8H_{16}). The major alkene is :

(a) $CH_3-C(CH_3)_2-CH=C(CH_3)-CH_3$

(b) $CH_3-C(CH_3)_2-CH_2-C(CH_3)=CH_2$

(c) $CH_3-CH(CH_3)-CH=CH-CH(CH_3)-CH_3$

(d) $CH_2=C(CH_3)-CH_2-CH_2-CH(CH_3)-CH_3$

208. An unknown alkene (*A*) reacts with 3 mole of H_2 gas in presence of platinum catalyst to form 1-isopropyl-4-methyl cyclohexane. When unknown alkene (*A*) is ozonized and reduced, following product are obtained

$H-\overset{O}{\overset{||}{C}}-H$, $H-\overset{O}{\overset{||}{C}}-CH_2-\overset{O}{\overset{||}{C}}-\overset{O}{\overset{||}{C}}-CH_3$, $CH_3-\overset{O}{\overset{||}{C}}-CH_2-\overset{O}{\overset{||}{C}}-H$

The alkene (*A*) is :

(a) (b) (c) (d)

209. Cyclohexene $\xrightarrow[\text{(2) Mg/ether}]{\text{(1) NBS}}$ (*A*) $\xrightarrow[CH_3-CH_2-Br]{H-\overset{O}{\overset{||}{C}}-CH(CH_3)_2}$ (*B*) $\xrightarrow[H_2O_2]{OsO_4}$ (*C*)

Product (*C*) is

(a) OEt, OH, OH

(b) OEt, H, OH, OH

(c) OEt, H, OH, OH

(d) Both (a) and (b)

210. The following reaction take place in high yields.

CO_2CH_3 $\xrightarrow[\Delta]{Hg(OAc)_2}$ Product

Use your knowledge of alkene chemistry to predict a product even though you have never seen this reaction before

(a) CO_2CH_3, HgOAc

(b) H, CO_2CH_3, HgOAc

(c) [structure: bicyclic ring with CO_2CH_3, methyl, gem-dimethyl and OH]

(d) [structure: bicyclic ring with CO_2CH_3, methyl, gem-dimethyl and OH]

211. o-Xylene $\xrightarrow[(2)\,Zn]{(1)\,O_3}$ $H-\overset{O}{\overset{\|}{C}}-\overset{O}{\overset{\|}{C}}-H$ (Glyoxal) $+ CH_3-\overset{O}{\overset{\|}{C}}-\overset{O}{\overset{\|}{C}}-CH_3$ (2,3-Butanedione) $+ CH_3-\overset{O}{\overset{\|}{C}}-\overset{O}{\overset{\|}{C}}-H$ (Pyrualdehyde)

What is the ratio of glyoxal to pyrualdehyde obtained in the above reaction ?

(a) 1 : 3 (b) 3 : 1

(c) 3 : 2 (d) 2 : 3

212. Toluene ($C_6H_5CH_3$) $\xrightarrow[\text{liq. } NH_3]{Na}$ (A) $\xrightarrow[Zn]{O_3}$ Products

Which of the following product cannot be obtained in above reaction ?

(a) $H-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-H$ (b) $CH_3-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-H$

(c) $CH_3-\underset{CHO}{\underset{|}{CH}}-\overset{O}{\overset{\|}{C}}-H$ (d) None of these

213. $(CH_3)_2C=C(CH_3)_2$ + $(CH_3)_3\overset{+}{N}-\overset{-}{O}$ + H_2O $\xrightarrow{OsO_4(10^{-4}\text{ mole})}$ $A + (CH_3)_3N$

2, 3-dimethyl-2-butane (0.025 mole); TMAO (0.034 moles)

(TMAO → trimethyl amine –N – oxide)

Product (A) is :

(a) $(CH_3)_2C-C(CH_3)_2$ epoxide (bridged by O) (b) $CH_3-\underset{OH}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}-\underset{OH}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}-CH_3$

(c) $CH_3-\overset{O}{\overset{\|}{C}}-CH_3$ (d) $CH_3-\overset{O}{\overset{\|}{C}}-C(CH_3)_3$

214. HO ... $\xrightarrow{H_3O^+} A$

Product (A) of the reaction is :

(a)

(b)

(c)

(d) None of these

215. OH $\xrightarrow[\Delta]{H^+}$ (A) (major)

Product (A) is :

(a)

(b)

(c)

(d)

216.

$$\underset{(a)}{(CH_3)_2C = CH_2} \qquad \underset{(b)}{CH_3(CH_3O)C = CH_2} \qquad \underset{(c)}{CH_3(CH_3OCH_2)C = CH_2}$$

Arrange the above in the decreasing order of reactivity towards HBr :

(a) $a > b > c$ (b) $b > a > c$

(c) $b > c > a$ (d) $a > c > b$

217. Which reaction has the lowest $\Delta G^{\ddagger}$ or (Activation-Energy)?

(a)

(b)

(c)

(d) HBr → Br

218. Which of the following will rearrange ?

(1)
(2)
(3)
(4)

(a) 1 (b) 1 and 3
(c) All (d) 1, 2, 4,

219. Which of the following is most likely to undergo a favorable hydride shift ?

(a)
(b)
(c)
(d)

220. Energy profile diagram for dehydration of 2-butanol using conc. H_2SO_4 is given below :

Product (b) of above reaction is :

(a) 1-butene (b) *cis*-2-butene
(c) *trans*-2-butene (d) *iso*-butene

221. How many alkene on catalytic hydrogenation given isopentane as a product ?

(a) 2 (b) 3

(c) 4 (d) 5

222. Which of the following would not rearrange to a more stable form ?

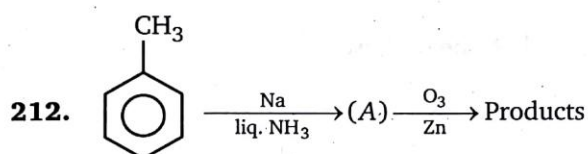
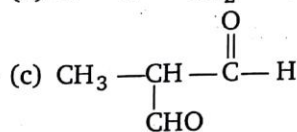
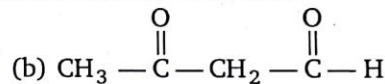
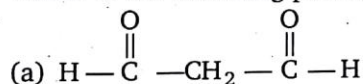
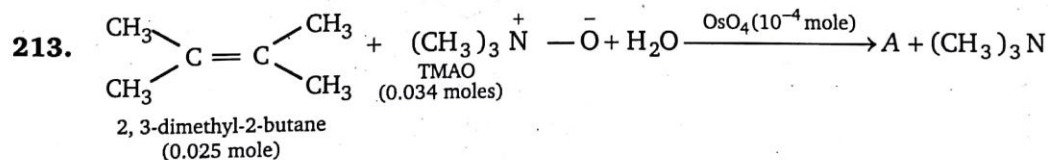
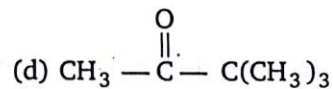
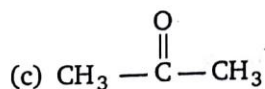
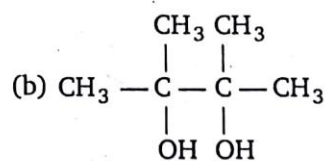
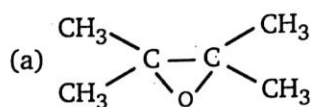
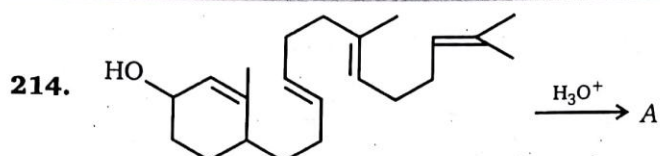
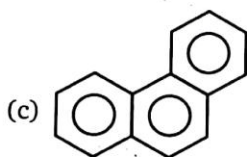
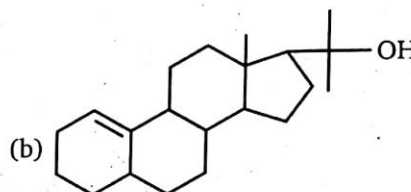
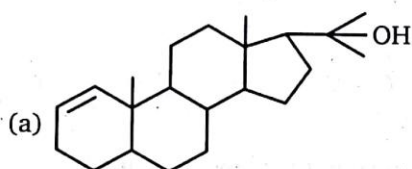
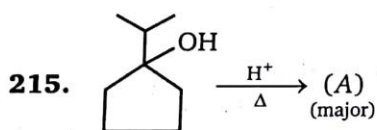
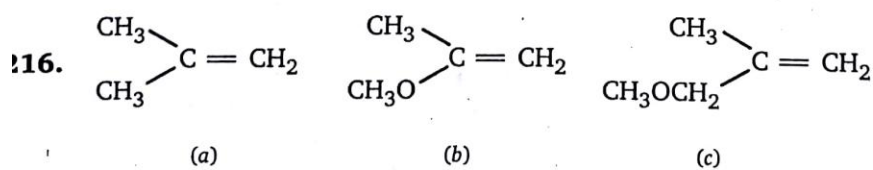
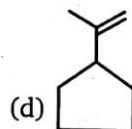
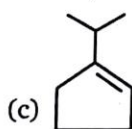
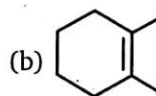
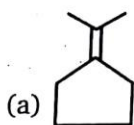
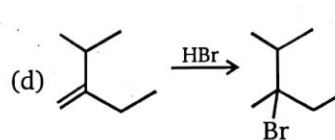
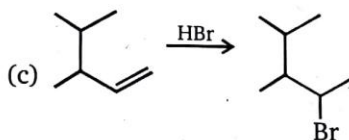
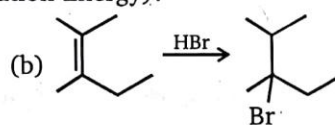
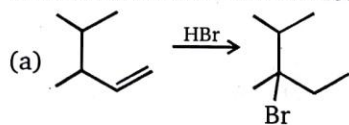
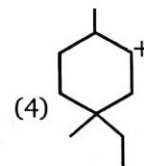
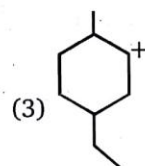
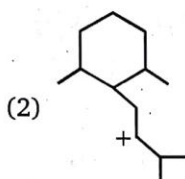
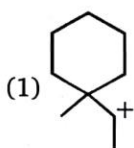
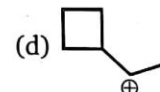
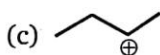
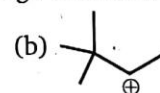
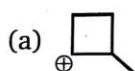
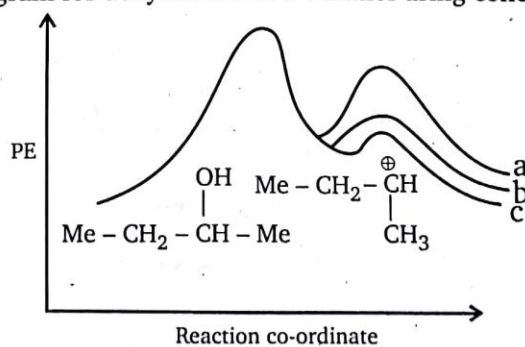
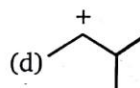
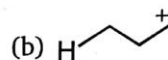
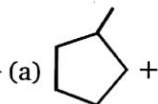
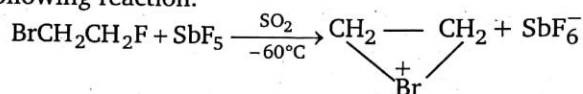
(a)

(b) H

(c)

(d)

223. Consider the following reaction.

$$BrCH_2CH_2F + SbF_5 \xrightarrow[-60°C]{SO_2} CH_2 — CH_2 + SbF_6^-$$
$$\overset{+}{Br}$$

In this reaction SbF_5 acts as:

(a) an acid (b) a base

(c) a nucleophile (d) an electrophile

224. $\xrightarrow{Br_2/hv}$ Major (X) $\xrightarrow[KOH/\Delta]{Alcoholic}$ Major(Y) $\xrightarrow[Peroxide]{H-Br}$ Major(Z):

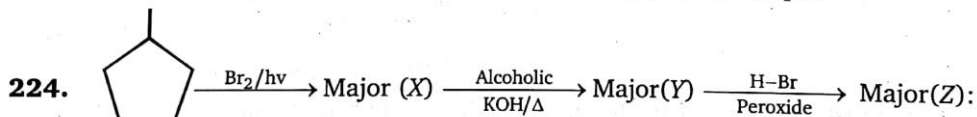
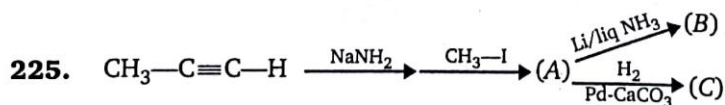
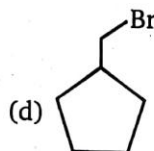
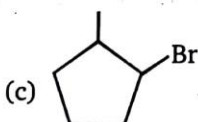
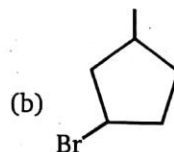
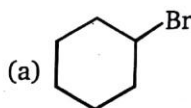
Product (Z) is:

(a)

(b) Br

(c) Br

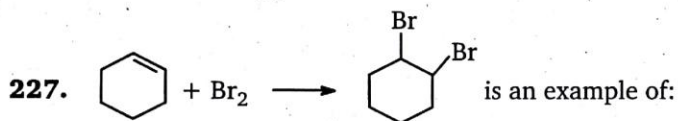
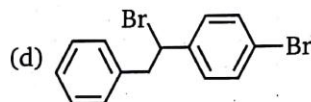
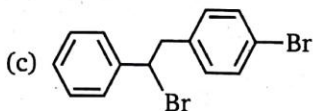
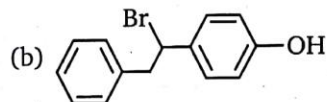
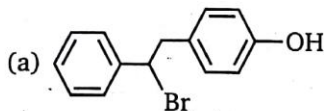
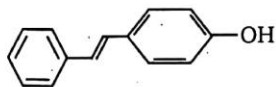
(d)

225. $CH_3—C \equiv C—H \xrightarrow{NaNH_2} \xrightarrow{CH_3—I} (A)$; $(A) \xrightarrow{Li/liq\ NH_3} (B)$; $(A) \xrightarrow[Pd\text{-}CaCO_3]{H_2} (C)$

Relation between (B) and (C) is:

(a) Enantiomer (b) Diastereomer

(c) Geometrical isomer (d) Meso

226. The reaction of HBr with the following compound would produce :

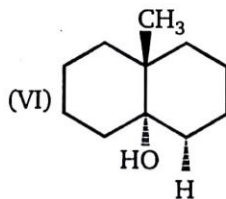
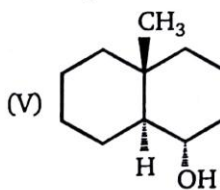
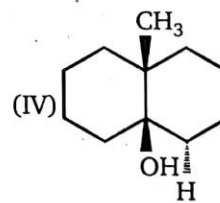
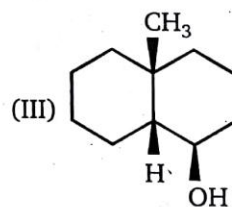
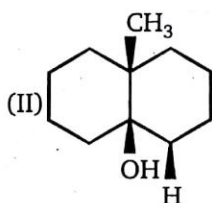
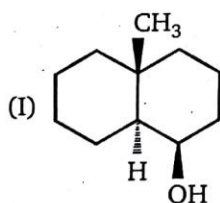
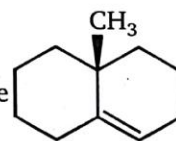
227. + Br_2 ⟶ (Br, Br) is an example of:

(a) Nucleophilic addition
(b) Nucleophilic substitution
(c) Electrophilic addition
(d) Electrophilic substitution
(e) Free radical substitution

228. Olefins can be hydrogenated by :

(a) Zinc and HCl
(b) Nascent hydrogen
(c) Raney Ni and H
(d) Lithium hydride in ether

229. What are the products obtained on hydroboration-oxidation of the given alkene (CH_3)

(I) CH_3, H, OH

(VI) CH_3, HO, H

(a) I and III
(b) II and IV
(c) II and VI
(d) III and V

ANSWERS — LEVEL 1

1.	(c)	**2.**	(d)	**3.**	(c)	**4.**	(d)	**5.**	(b)	**6.**	(b)	**7.**	(c)	**8.**	(c)
9.	(c)	**10.**	(d)	**11.**	(b)	**12.**	(d)	**13.**	(c)	**14.**	(b)	**15.**	(b)	**16.**	(c)
17.	(d)	**18.**	(d)	**19.**	(b)	**20.**	(d)	**21.**	(b)	**22.**	(a)	**23.**	(b)	**24.**	(b)
25.	(b)	**26.**	(b)	**27.**	(d)	**28.**	(b)	**29.**	(d)	**30.**	(b)	**31.**	(c)	**32.**	(b)
33.	(a)	**34.**	(b)	**35.**	(b)	**36.**	(b)	**37.**	(b)	**38.**	(b)	**39.**	(b)	**40.**	(b)
41.	(d)	**42.**	(e)	**43.**	(c)	**44.**	(c)	**45.**	(a)	**46.**	(c)	**47.**	(c)	**48.**	(b)
49.	(b)	**50.**	(b)	**51.**	(b)	**52.**	(a)	**53.**	(b)	**54.**	(d)	**55.**	(b)	**56.**	(c)
57.	(c)	**58.**	(b)	**59.**	(c)	**60.**	(a)	**61.**	(b)	**62.**	(d)	**63.**	(a)	**64.**	(b)
65.	(d)	**66.**	(b)	**67.**	(d)	**68.**	(a)	**69.**	(c)	**70.**	(d)	**71.**	(d)	**72.**	(c)
73.	(d)	**74.**	(c)	**75.**	(a)	**76.**	(c)	**77.**	(d)	**78.**	(b)	**79.**	(d)	**80.**	(d)
81.	(c)	**82.**	(b)	**83.**	(a)	**84.**	(a)	**85.**	(a)	**86.**	(d)	**87.**	(b)	**88.**	(b)
89.	(c)	**90.**	(d)	**91.**	(b)	**92.**	(b)	**93.**	(a)	**94.**	(a)	**95.**	(a)	**96.**	(d)
97.	(b)	**98.**	(a)	**99.**	(c)	**100.**	(d)	**101.**	(b)	**102.**	(b)	**103.**	(d)	**104.**	(b)
105.	(b)	**106.**	(c)	**107.**	(b)	**108.**	(b)	**109.**	(d)	**110.**	(d)	**111.**	(c)	**112.**	(b)
113.	(a)	**114.**	(b)	**115.**	(c)	**116.**	(a)	**117.**	(b)	**118.**	(b)	**119.**	(b)	**120.**	(d)
121.	(b)	**122.**	(c)	**123.**	(a)	**124.**	(b)	**125.**	(d)	**126.**	(a)	**127.**	(b)	**128.**	(c)
129.	(d)	**130.**	(a)	**131.**	(c)	**132.**	(d)	**133.**	(c)	**134.**	(a)	**135.**	(d)	**136.**	(c)
137.	(b)	**138.**	(d)	**139.**	(d)	**140.**	(b)	**141.**	(b)	**142.**	(b)	**143.**	(b)	**144.**	(b)
145.	(b)	**146.**	(c)	**147.**	(b)	**148.**	(a)	**149.**	(d)	**150.**	(b)	**151.**	(a)	**152.**	(d)
153.	(c)	**154.**	(c)	**155.**	(b)	**156.**	(c)	**157.**	(a)	**158.**	(a)	**159.**	(b)	**160.**	(c)
161.	(b)	**162.**	(c)	**163**	(b)	**164.**	(d)	**165.**	(d)	**166.**	(b)	**167.**	(b)	**168.**	(a)
169.	(c)	**170.**	(b)	**171.**	(b)	**172.**	(d)	**173.**	(b)	**174.**	(c)	**175.**	(b)	**176.**	(b)
177.	(b)	**178.**	(c)	**179.**	(b)	**180.**	(c)	**181.**	(b)	**182.**	(b)	**183.**	(c)	**184.**	(c)
185.	(c)	**186.**	(b)	**187.**	(a)	**188.**	(b)	**189.**	(b)	**190.**	(b)	**191.**	(a)	**192.**	(b)
193.	(c)	**194.**	(b)	**195.**	(c)	**196.**	(c)	**197.**	(b)	**198.**	(a)	**199.**	(b)	**200.**	(c)
201.	(c)	**202.**	(c)	**203.**	(b)	**204.**	(d)	**205.**	(b)	**206.**	(c)	**207.**	(b)	**208.**	(b)
209.	(b)	**210.**	(b)	**211.**	(c)	**212.**	(c)	**213.**	(b)	**214.**	(a)	**215.**	(b)	**216.**	(b)
217.	(d)	**218.**	(c)	**219.**	(a)	**220.**	(b)	**221.**	(b)	**222.**	(c)	**223.**	(d)	**224.**	(c)
225.	(b,c)	**226.**	(b)	**227.**	(c)	**228.**	(c)	**229.**	(d)						